The Federal Plan for Meteorological Services And Supporting Research

FISCAL YEAR 1975

FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

U.S. DEPARTMENT OF COMMERCE/National Oceanic and Atmospheric Administration

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JUNE 1974
WASHINGTON, D.C.

PREFACE

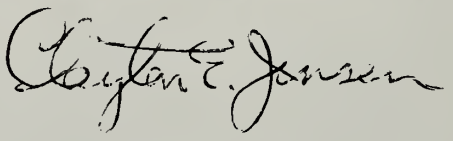
This is the tenth Federal Plan in an annual series developed by the Federal Coordinator for Meteorological Services and Supporting Research in response to Section 304 of Public Law 87-843. The Plan describes the Nation's meteorological programs designed to reduce the economic and social impact of natural disasters, promote the Nation's welfare and economy, preserve and enhance the environment and strengthen the national security.

The introductory section to this Plan highlights many aspects of interagency cooperation that is so essential to meet the needs for meteorological services now and for the challenges of the future. This section is followed by a brief fiscal summary of the overall Plan.

Basic and Specialized Meteorological Services and Supporting Research are described in the next section along with the operational and research programs for fiscal year 1975. The fourth major section of this Plan treats meteorological services from the functional viewpoint. Observations, analyses and forecasts, communications, dissemination, and general agency support are covered.

The final section describes the meteorological satellite program as a separate discussion. The last page of this Plan lists the publications prepared, or in the process of preparation, by the Federal Coordinator for Meteorological Services and Supporting Research.

The coordination of weather activities and the preparation of the Federal Plan is performed by the interagency committees shown on the inside front cover. These committees and their subcommittees conduct systematic, continuous reviews of basic and specialized meteorological requirements, services, and supporting research according to the guidelines set forth in the Office of Management and Budget Circular A-62.



Clayton E. Jensen
Federal Coordinator for
Meteorological Services and
Supporting Research

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Cooperation and Coordination In Meterology

On November 13, 1963, the Bureau of the Budget (now the Office of Management and Budget) issued Circular A-62 in response to Section 304 of Public Law 87-843 directing the Department of Commerce to:

- With the advice and assistance of other agencies concerned, establish procedures designed to facilitate a systematic and continuing review of basic and specialized meteorological requirements, services and closely related supporting research.
- To the maximum extent practicable and permitted by law, provide those basic meteorological services and supporting research needed to meet the requirements of the general public or the common requirements of other agencies.
- Prepare and keep current a plan, and obtain periodic information on its implementation for the efficient utilization of meteorological services and supporting research.

  Establish appropriate arrangements for obtaining continuing advice from the principle agencies concerned.

In response to the last of the above directives, the Federal Coordinator for Meteorological Services and Supporting Research structure shown on the inside cover was developed. Under the direction of the Federal Coordinator, an annual Federal Plan has been published. This is the tenth edition of the plan with the purpose to:

- Provide the Congress with a single source for reviewing the overall Federal program in meteorological services and supporting research.
- Provide the Federal agencies with an overall framework within which to review their own plans and programs in meteorological services and supporting research.
- Provide the Administration with a basis for better management of an essential program which involves many Federal agencies.

Through the interdepartmental committees and working groups who do the groundwork upon which the Federal Plan is based, a close balance has been achieved between the responsibilities of the individual agencies and the constraints of budget and manpower demanded for the efficient management of the overall Federal meteorological program. From the perspective of the past decade, this balance has evolved primarily as a natural result of the commonality of interests and goals among the agencies. This balance is spurred by the opportunities to interrelate the various agency objectives, rather than as the result of mergers of personnel, equipment, or facilities.

The first issue of the Federal Plan noted that "the best guarantee of achieving an economical use of Federal meteorological resources is to have all agencies working together toward a common goal". Striving toward the common goal has kept the development of agency programs on well coordinated paths, while the variety of agency responsibilities has maintained a healthy diversity in perspective. With their perception of the common goal sharpened by the Federal coordinating mechanism, the Federal agencies have built upon the achievements of the past decade to prepare for the challenges of the next.

THE 1963-1973 DECADE

The Nation's meteorological services and supporting research programs have seen a decade of remarkable progress in both national and international weather activities, largely the result of coordination and cooperation among the several agencies concerned. An assessment of this cooperation is given in terms of some of the significant accomplishments that have occurred in observing and forecasting the

weather; communicating and disseminating weather data and information; and improving these services. Each of these accomplishments rests upon joint decisions and actions taken by Federal meteorological agencies as a whole, through the process of interdepartmental coordination and planning.

OBSERVATIONS

The observation function is characterized by a mix of complementary elements operated by the respective Federal agencies, all of which contribute to a total monitoring system for determining the existing state of the atmosphere. These observing elements include satellites of the National Aeronautical and Space Administration, and the Departments of Commerce and Defense, radars of Commerce, Defense, and the Federal Aviation Administration, and aircraft of NASA, Commerce and Defense along with a variety of manned and automated land and ocean surface observation stations and platforms operated by Defense, Commerce, FAA, and Coast Guard.

Between the turn of the century and 1960, there had been little change in the method of weather observing for forecasting; and there had been little change in methods of acquiring upper air data since the mid-40s. During the 1960s, the advent of meteorological satellites brought entirely new perspectives to weather observation. At first limited to a qualitative overview of cloud systems, satellite observations were soon enhanced to include derived wind fields, high resolution surface information, detailed cloud structure, and vertical temperature and humidity profiles. Today, satellites are an indispensable part of meteorological services of the world.

The cooperation between NASA and Commerce has been particularly fruitful in transforming satellite technology into an important national and international contribution to meteorology. NASA's contribution in the form of research, design, construction and launch of the spacecraft has complemented Commerce's contribution to the instrumentation and operation of the satellite observing system. This collaboration which has worked so well on the earlier satellite programs continues in an effort which will consist of two complementary satellite systems--geostationary and polar orbiting--specifically designed to meet the observational needs of the two major tasks of operational weather services--environmental warnings and predictions.

The Geostationary Operational Environmental Satellite (GOES) system, two satellites in geostationary orbit, will transmit two cloud pictures per satellite per hour of the North American continent and adjacent oceans. This near-continuous monitoring of weather systems including the development of severe storms will provide vital information for environmental warning services. The GOES system will also provide the capability to interrogate and collect weather data from remote stations.

The ITOS system of polar-orbiting satellites with an array of sensors for obtaining twice-per-day images of global cloudiness and vertical temperature distributions will provide weather data and information needed for numerical models in support of environmental prediction services.

The development of third generation systems, designated TIROS N, reflects a three-way collaboration among the Departments of Defense and Commerce and NASA. The spacecraft of this operational system will be based upon the satellites of the Defense Meteorological Satellite Program, and current plans are to use Defense launch services as well as launch vehicles on a reimbursable basis. Aboard the spacecraft will be advanced sensors developed by NASA. Once in orbit, the civilian satellites will be operated by NOAA as part of the National Operational Environmental Satellite Service. Besides the advanced visual and infra-red imaging sensors, satellites of the TIROS N series will have the capability to locate and interrogate moving observation platforms such as drifting buoys and balloons. The improved vertical temperature sounding instrumentation will combine with the high-resolution visual images to bring greatly enhanced capabilities to bear on the challenging problems of forecasting severe local storms.

While satellites provide the capability for large-scale monitoring of developing storms, more detailed and quantitative information is required for warnings as storms threaten populated areas. Radar is a major technique for close-in monitoring of severe storms. From a beginning in the late 1940s with a loosely knit scattering of surplus World War II aircraft radars limited to local use, a basic weather radar network has evolved to provide effective radar coverage to the Nation. The basic system is operated by Commerce with participation by Defense and FAA. FAA air route traffic control radars serving Air Route Traffic Control Centers in the western U.S. provide essential weather data in the mountainous regions. When

available Defense radars are used in the basic network for storm detection areas where Commerce has no radar services and are also used to provide backup to Commerce's basic network radars.

Remoting systems are installed on many of the basic network weather radars to transmit the radar scope information to various users. Properly equipped Federal and private groups can dial-in to sites with remoting system transmitters to follow the real-time development and movement of storms affecting their areas of interest. While useful, the remote scopes are not adequate to support warning programs in areas of frequent severe storms. As a result, there are plans to procure additional radars to fill gaps in the basic weather radar network and replace obsolete local warning radars used in areas of frequent severe storm activity. These additional local warning radars will be operated on an as needed basis.

The present manual methods used for taking weather radar observations and then collecting and compositing them for facsimile transmission cause time delays and require substantial manpower. Automation of this process to aid the operator in providing more accurate and timely data for issuance of local advisories and warnings of severe storm conditions is planned.

Another complementary observational technique involves the use of weather reconnaissance aircraft particularly for determining the location, intensity, structure, and movement of tropical cyclones and winter storms located over ocean areas of the earth. This quantitative information on storm conditions is essential for accurate prediction of the movement and intensity of hurricanes and other storms and can only be obtained by aircraft penetration of the storms. Weather reconnaissance efforts can be traced back at least to World War II with a history of aircraft types extending from the B-17 to today's jet-powered aircraft. Defense supports Commerce's civil hurricane and winter storms program with Air Force WC-130 and Navy P-3 aircraft. These planes are equipped with modern instrumentation for acquiring and delivering the critical weather data needed for operational hurricane and winter storm forecasting. Commerce's Research Flight Facility provides limited backup for Defense's reconnaissance aircraft in emergency situations.

Historically, the surface-based part of the observing system has included the participation of the largest number of agencies. The Department of Commerce has the responsibility for most of the synoptic weather observations which are part of a world-wide network. However, where it is advantageous to the Government, the FAA shares in this effort and both provide the aviation weather observations so necessary for flight safety. In a similar way, Defense and Coast Guard take surface observations from a variety of land and marine facilities. As an example, the

The U.S. Coast Guard Cutter TANEY provides critical surface, upper air, and radar weather observations for the 5 months of the year it mans Ocean Weather Station HOTEL.

Coast Guard provides surface weather observations from its high endurance cutters while underway and they also man the Ocean Weather Station (OWS) HOTEL off the east coast for eight months of the year during the hurricane and winter storm seasons. Commerce personnel on cutters at OWS HOTEL provide upper air observations routinely and radar weather data for five months when the USCGC TANEY is on-station.

Supplementing these manned facilities are Commerce's experimental buoys located off the east coast, in the Gulf of Mexico, off the Pacific northwest, and in the Gulf of Alaska. The positioning, maintaining, and collection of data from these buoys are carried on as a coordinated effort between Commerce and the Coast Guard.

New concepts involving modern technology for automating and remoting observations are being developed on a cooperative basis involving mainly the Departments of Commerce and Transportation. All agencies concerned in this program will benefit as they turn towards more and more automation with less requirements for manned facilities (e.g., light houses) in areas of observational importance.

ANALYSIS AND FORECASTING

The history of cooperative analysis and forecasting efforts goes back to the mid-1940s when the Weather Bureau-Army-Navy (WBAN) center was formed to provide a source for the analyses and forecasts distributed over the then rudimentary facsimile network. Although specialized centers to support military requirements functioned alongside WBAN, the centralized facility still continued to supply the basic analytical and forecasting service for the meteorological community. As the science of prediction developed, this center gradually evolved into the Joint Numerical Weather Prediction unit (JNWP). In the present day, the JNWP facility has become the National Meteorological Center (NMC) of the Department of Commerce, one of a small number of national and international centers that serve the world's meteorological organizations. The NMC continues to provide the basic analyses and forecasts for the common requirements of the community over the period from 12 hours to five days, while the Navy's Fleet Numerical Weather Central at Monterey, Calif., and the Air Force's Global Weather Central at Offutt AFB, Nebr., serve the specialized needs of the military. The three centers, however, work closely together in developing new scientific forecast models. Furthermore, backup plans provide for limited but uninterrupted civil service from the military centers in the event of power failure or technical breakdown at the NMC.

The past decade at NMC has seen improvements in computer speed and capacity that would have scarcely been credible ten years ago. The flexibility and the sheer power and speed of the fourth-generation machines now coming on line will allow the use of much more complex numerical prediction models. Equally important will be the capability to use data obtained at any time, rather than being restricted to the batch processing of data obtained at the traditional twice-daily synoptic observation hours. The memory capacity of the new computers also allows computation in smaller, more detailed steps of time and space. Based on experiment the result will be to achieve improvements in short-range forecasts, 0 to 12 hours, and the incorporation of detailed terrain effects into forecasts for all time periods.

The ability to handle the myriad of necessary computations will become more and more important as the emphasis increases on long-range forecasting for periods of two weeks and longer. There are still formidable technical and theoretical difficulties ahead and the requirement is clear for increased emphasis on this challenging problem.

COMMUNICATIONS AND DISSEMINATION

Communications facilities provide the links that distribute observational data to the processing centers and forecasters for use in preparing meteorological forecasts and warnings.

The FAA operates the basic teletypewriter networks for the collection and distribution of alphanumeric meteorological information. Defense collects and distributes meteorological information from its world-wide facilities to meet its specialized needs. Commerce collects and distributes information through its role as a WMO World Meteorological Center and operates specialized circuits to meet internal needs. Data collected by the various agencies are made available to other agencies through switching centers and high speed communications links.

In addition to the distribution of alphanumeric information, Commerce operates the primary network for distribution of graphical products. Over 1,000 subscribers receive current weather analyses

and prognostic charts; over this facsimile network approximately 300 of those subscribers are from Commerce. Defense operates a facsimile network for the distribution of its specialized meteorological charts and forecasts and also subscribes to the Commerce system.

Centrally prepared forecast information is transmitted over many of the same communications links which collect observational data. Some users obtain meteorological information directly from these communications systems. However, a large majority of the population do not have access to these systems and, for most users, the information has to be interpreted and converted by a forecaster, thus a variety of other dissemination systems are used for providing forecasts and warnings. Examples of these systems are Commerce's VHF-FM and NOAA Weather Wire Service for the dissemination of forecasts and warnings directly to the public, Defense Civil Preparedness Agency (DCPA) National Warning System (NAWAS) for the dissemination of warnings to action agencies; and the cooperative fire weather dissemination circuits jointly funded by Commerce, Agriculture, and Interior for disseminating fire weather forecasts and warnings. These circuits are discussed in detail in later sections of the Plan.

Programs, such as Commerce's Automation of Field Operations and Services (AFOS), offer the capability to significantly increase Federal meteorological communications and dissemination capabilities within the near future. AFOS will also increase the productivity of meteorologists by freeing them of routine, clerical tasks and permitting more time to be spent on analysis and forecasting.

WORLD WEATHER PROGRAM

The United States supports international cooperation in meteorology and participates in the World Weather Program, an internationally coordinated effort that comprises the World Weather Watch (WWW), the Global Atmospheric Research Program (GARP), and a Systems Design and Technological Development effort. The goals of these programs are to provide the data and knowledge needed to extend the range and accuracy of weather forecasts, to understand the physical basis of climate and climatic change, and to establish new bonds of international cooperation and joint activity to meet the need of nations for services concerning atmospheric conditions. From its inception, the World Weather Program has received increasing support from the world community.

Large-scale observation experiments play an important part in the Global Atmospheric Research Program (GARP). The first of the GARP experiments, the Barbados Oceanographic and Meteorological Experiment (BOMEX), was conducted in 1969 as a cooperative venture between the United States and the Government of Barbados. BOMEX was designed to observe and subsequently to parameterize the small-scale exchange of energy, momentum, and water vapor between the ocean and the atmosphere. Data from this experiment and related analyses are a continuing source for improved knowledge about air-sea interactions. Fresh insights have been obtained concerning the structure of the planetary boundary layer over the tropical ocean. Some of the expertise developed in BOMEX is now being utilized in preparations for the GARP Atlantic Tropical Experiment (GATE).

One of the most important processes in understanding the transient behavior of the atmosphere is the role of tropical circulations in driving the global circulation and in forming tropical cyclones. The observational phase of the GATE is scheduled from June 15 through September 1974, in the equatorial belt of the Atlantic. The GATE will examine tropical convection processes which transfer large quantities of heat and moisture from vast expanses of tropical oceans into the atmosphere, especially the details of tropical cloud clusters imbedded in large-scale systems. The data will be used in the development and testing of numerical models.

The GATE is the first international GARP research effort involving many nations, both developed and developing. This is a positive step in continuing efforts to encourage international cooperation. Twelve nations plan substantial contributions to the experiment. Six U.S. Federal agencies--the Department of Commerce, Defense, Transportation and State, National Science Foundation, and the National Aeronautical and Space Administration--have committed major resources. This subject is treated in greater detail in the *World Weather Program Plan for Fiscal Year 1975*.

Underpinning the success of the First GARP Global Experiment (FGGE) will be the testing of all facets of the overall system for acquisition and handling of data. This will be accomplished during the Data Systems Test, which will be conducted in 1974 overlapping the GATE observational period.

In addition to BOMEX and GATE, experiments that seek to understand specific oceanic-atmospheric processes in support of FGGE in selected regions include: The Monsoon Experiment in the Arabian Sea during the southwest monsoon season; the Polar Experiment, which will study energy processes in polar regions; and the Air Mass Transformation Experiment to study surface-boundary layer energy transfer and convection in cold air masses moving from Asia out over the relatively warm waters of the westernmost Pacific Ocean.

The application of available global atmospheric models to support improved weather service and the development of improved models require observations that define the state of the entire global atmosphere. The FGGE, planned for 1977-1978, is directed especially toward providing these observations. The WWW will provide the basic data, supplemented by special observing systems, possibly including those tested during GATE and the Data Systems Test. The experiment will continue for about 12 months and will include two special 1-month intensive observing periods. Complete global data sets collected during the experiment will be made available to users, especially research groups for refinement of atmospheric models and for studies of optimum observing systems.

THE CHALLENGES OF THE NEXT DECADE

Increasing demands expected within the next ten years emphasize the pressure on existing stores of natural resources. The available amount, movement, and storage of heating resources, for example, will have to be handled in response to forecasts of demand for months and weeks ahead. This suggests renewed interest in seeking improvements in predicting long-range climatic changes.

The need for increasing agricultural production certainly will be a focus of attention. Again, the importance of long-range forecasts deserves attention for planning purposes. On the other end of the scale, at harvesting time, short-range forecasts out to 12 hours or so will play an important role in maximizing production yields. The preservation of our forested areas is a closely related item of importance. Improved techniques for understanding and handling fire weather forecasting should also receive attention.

A shortage of living space, especially in crowded urban areas, may lead to development of additional suburban and ex-urban housing in areas more and more exposed to the environment. This is especially true when housing is in the form of mobile homes which are so vulnerable to severe thunderstorms and tornadoes. Thus, more emphasis should be placed on the shorter end of the forecast scale. Even for ordinary comfort and recreational purposes, the public may well demand more accurate and timely six to twelve hour forecasts.

In short, the next decade will almost certainly see both our society and our economy become more vulnerable to the effects of weather. It seems likely that the major efforts will be felt in persistent exceptional weather such as droughts, cold spells, and heat waves and in violent weather, such as hurricanes, tornadoes, ice storms, and blizzards.

To summarize, whereas the main emphasis of the past decade has been upon the tools required for better 12-hour to three-day forecasts, the future decade will call for increasing emphasis on the short-range service needed to cope with severe local storms and on the long-range service needed to support such weather sensitive activities as planning for fuel distribution, agricultural planning, and construction.

Summary of Fiscal Data

The following tables summarize fiscal information concerning meteorological expenditures of the Federal Government for meteorological services and supporting research. Only the research that has as its immediate objective the improvement of meteorological services is reported; activities integral to Federal programs in weather modification, water resources, and air-sea interaction are not within the purview of this Plan.

All FY 1975 fiscal data contained in this Plan are reflected in the President's budget and should be used for planning purposes only. The scheduling and implementation of these programs after FY 1975 are subject to additional analysis and further judgment.

The fiscal information[1] is presented by agency (table 1) and by service (table 2) and consists of FY 1974 data, planned activities for FY 1975, and the net differences for meteorological operations and for supporting research.

In FY 1975, operational programs amount to $492,701,000. This represents a net increase of only $146,000 over planned expenditures by all the Federal agencies in FY 1974. Although this indicates essentially level funding from a Federal viewpoint, there are a number of significant program actions within the individual agencies, both increases and decreases, which, when added together, results in a small total net change. Also, there is a marked increase in the FY 1974 figures over that reported last year for the same period--about $56 million. This increase stems primarily from three factors. The Department of Defense, included for the first time,

Table 1.--Federal plan for meteorological operations and supporting research, by agency
(Thousands of dollars)

Agency	Operations			Supporting research			Total		
	FY 74	FY 75	Net difference	FY 74	FY 75	Net difference	FY 74	FY 75	Net difference
Agriculture	.....	.....	.....	943	1,033	+90	943	1,033	+90
AEC	1,757	1,893	+136	429	470	+41	2,186	2,363	+177
Commerce	219,398	222,764	+3,366	11,362	11,535	+173	230,760	234,299	+3,539
Defense	210,624	203,679	-6,945	15,625	18,174	+2,549	226,249	221,853	-4,396
EPA	600	.....	-600	8,430	8,430	0	9,030	8,430	-600
NASA	1,523	1,322	-201	33,713	36,617	+2,904	35,236	37,939	+2,703
Transportation:									
Coast Guard	6,533	2,807	-3,726	.....	.....	.....	6,533	2,807	-3,706
FAA	52,120	60,236	+8,116	7,873	7,700	-173	59,993	67,936	+7,943
Total	492,555	492,701	+146	78,375	83,959	+5,584	570,930	576,660	+5,730

[1] Funds specified throughout this Plan represent the total obligational authority required for each year and are presented by Fiscal Year. Funds are given in thousands of dollars on all tables.

Table 2.–Federal plan for meteorological operations and supporting research, by service
(Thousands of dollars)

Service	Operations			Supporting research			Total		
	FY 74	FY 75	Net difference	FY 74	FY 75	Net difference	FY 74	FY 75	Net difference
Basic	247,600	246,672	-928	44,565	47,625	+3,060	292,165	294,297	+2,132
Aviation	172,529	174,685	+2,156	9,015	8,800	-215	181,544	183,485	+1,941
Marine	10,549	11,267	+718	1,021	1,364	+343	11,570	12,631	+1,061
Space operations	8,862	8,288	-574	300	200	-100	9,162	8,488	-674
Agriculture	2,249	2,249	.....	943	1,033	+90	3,192	3,282	+90
General military	35,290	34,879	-411	13,612	15,960	+2,348	48,902	50,839	+1,937
Fire/air quality	3,603	3,003	-600	8,490	8,507	+17	12,093	11,510	-583
Other specialized	11,873	11,658	-215	429	470	+41	12,302	12,128	-174
Total	492,555	492,701	+146	78,375	83,959	+5,584	570,930	576,660	+5,624

the Defense Meteorological Satellite Program (DMSP) in the Federal Plan. The inclusion of this program increases the fiscal totals by $18.7 million in FY 1974 and $20 million in FY 1975. The Department of Commerce obtained a one-time supplemental appropriation of $9 million to replace the ITOS E satellite that failed to orbit, and then the upward trend in cost of living contributed to increased costs.

The operational program changes within the Department of Commerce are directed primarily toward improving the severe weather warning system and expanding the use of new technology to provide for more efficient operations, all designed to reduce the economic and social impact of natural disasters. Commerce's increased funding includes $1,500,000 for additional weather radars to fill gaps in area coverage thus providing more complete detecting, tracking, and warning services of severe weather conditions; $6,173,000 for continuation of the GOES B and C procurement and initial procurement of long lead items of ground equipment for the third generation polar orbiting satellite; $330,000 to provide 11 community preparedness specialists to assist communities with their severe weather preparedness plans; and finally $3,471,000 to begin the automation of field stations to improve efficiency and relieve forecasters of some of the more routine functions so they may concentrate more on the monitoring and forecasting of changing weather conditions. All of the increases reported by Commerce above are to improve Basic Meteorological Service which benefits all Federal agencies and the general public.

The Department of Defense has continued to reduce forces accounting for sizable reduction in its meteorological programs. In addition, a number of Defense programs included in the FY 1974 budget were completed which has the effect of reducing the Defense FY 1975 base program. The more significant programs completed in FY 1974 include the relocation of the representative observation sites, the procurement of USAF tactical radars, and the conversion of USAF reconnaissance fleet to the WC-130H aircraft. Although the number of aircraft assigned the primary mission of weather reconnaissance is being reduced, Defense still maintains the capability to provide the required aerial reconnaissance of hurricanes and east coast winter storms. Offsetting these fiscal decreases, Defense is planning a major expansion of computer power at both the Air Force Global Weather Central and the Fleet Numerical Weather Central to improve the application of the large amounts of available satellite data and improve military services. The increases for these computers amount to $5,788,000. In addition, Defense is planning improvements in communications centers at Croughton, England, Carswell AFB, Tex., Torrejon Air Base, Spain, and Incirlik Air Base, Turkey, in an amount totalling $1,549,000. An increase in USAF training requirements accounts for a further increase of $1,292,000. The planning improvements in the overseas communications centers will aid Commerce

in providing better Basic Meteorological Service through improved reception of basic data.

The Federal Aviation Administration, in FY 1975, is planning a number of programs to enhance service to aviation. The more significant items include the purchase of additional surface observing equipment for airfields at $5,025,000, the purchase of equipment for the recording and continuous broadcast of weather information at $1,856,000, the expansion of its En Route Flight Advisory Service to 19 additional locations at $2,664,000, and continuing the program of providing or relocating teletypewriters at Commerce's airport weather stations for $1,133,000. This latter item along with the additional observing equipment will also enhance Commerce's capability to provide services to the general public.

As a result of new data collection techniques from satellites and a re-evaluation of mission requirements, the U.S. has withdrawn from participation in the North Atlantic Ocean Station program during the past year. Since these stations were manned with U.S. Coast Guard cutters, this retrenchment has reduced the USCG program in FY 1975 by $3,300,000. The Ocean Weather Station HOTEL located off the east coast of the U.S. is not affected by this change and will continue to provide information to support hurricane and east coast winter storm warnings.

In FY 1975, the supporting research programs amount to $83,959,000 representing about 41 percent of the total Federal expenditures planned for meteorological research expected to be reported to the Interdepartmental Committee for Atmospheric Sciences of the Federal Council for Science and Technology. The increase of $5,584,000 over that reported for FY 1974 stems primarily from the Defense and NASA programs. The research programs of the remaining agencies are relatively level funded.

Commerce, from an analysis of its research programs, has changed the category of some of its activities from fundamental to supporting research. This accounts for the increase of over $6 million reported in this Plan for FY 1974 over that reported in last year's Plan for FY 1974. No changes in research activity are indicated by this action. In FY 1975, Commerce is expanding its effort in developing ground based remote sensors to the extent of $350,000 to provide better capability to study the small scale motions and systems of the atmosphere.

The Department of Defense budget reflects a planned increase of $2,549,000 for supporting research in FY 1975. This increased effort is being directed primarily toward developing improved capabilities to display and use weather data from meteorological satellites in more direct support of defense forces.

NASA's decision last year to report only on spacecraft, controls, and subsystems which are directly associated with meteorological research continues to be reflected in its funding totals. This is particularly evident in the section on Weather Satellites. Compared to the FY 1974 Plan, the increase in the funding level for "Flight Projects" is attributed to increased costs for the development of experiments for Nimbus F, costs associated with the extension of the launch of both SMS A and SMS B and increases in the Operational Satellite Improvement Program. After the launch of SMS A and SMS B and Nimbus F in the first half of CY 1974, the shift in effort will be from "Flight Projects" to "Data Analysis and Applications". The increase in this latest category is also due to the completion of the GARP Data Systems Test and the shift in the emphasis in the GARP effort away from "Instruments and Experiments". The slight increase of the FY 1975 funding totals over those for FY 1974 is due primarily to an increase in the funding level of the Nimbus G program.

Table 3 shows the distribution by agencies of operational costs between the United States and overseas areas. This table clearly illustrates the heavy investment in meteorological services required to meet military needs outside the conterminous States. Certain funds, such as those for weather reconnaissance and some contracts for missile range support, are included in the column headed "States" because funds are contracted for or reported by the parent unit within the United States, although the operations actually may be performed in overseas areas.

Table 4 shows the extent to which Federal agencies made use of each other's capabilities through the purchase of meteorological services and/or supporting research by interagency fund transfers in FY 1974.

Table 3.--Distribution of operational costs, conterminous States and overseas, by agency
(Thousands of dollars)

Agency	FY 73		FY 74	
	States	Overseas	States	Overseas
Commerce	207,527	11,871	210,893	11,871
Defense	165,397	45,227	160,934	42,745
Transportation:				
Coast Guard	1,011	5,522	647	2,160
FAA	47,976	4,144	55,504	4,732
EPA	600	.....	.....	.....
AEC	1,757	.....	1,893	.....
NASA	1,523	.....	1,322	.....
Total	425,791	66,764	431,193	61,508

Table 4.--Interagency fund transfers for meteorological operations and supporting research, fiscal year 1974

Agency		Funds[1]	
Transferred from	Transferred to	Operations	Research
AEC	Commerce	1,448	399
DOD	Commerce	1,284	125
	Interior (USGS)	.....	10
NASA	Commerce	1,072	.....
	DOD (USAF)	8	.....
FAA	Commerce	316	782
	NASA	.....	590
	DOD	.....	290
DOC	NASA	32,456	.....
EPA	Commerce	.....	1,069

[1] Thousands of dollars.

Meteorological Services

INTRODUCTION

In very broad terms, primary national objectives for weather service to the Nation include:

- Reduce economic and social impact of natural disasters
- Promotion of the Nation's welfare and economy
- Preservation and enhancement of the quality of the environment
- National security

To meet these objectives the Federal Government provides two types of meteorological services--Basic and Specialized. The Basic Meteorological Service meets public needs, fulfills requirements common to two or more agencies, and provides the foundation for disaster warnings and the Specialized Services. The Specialized Meteorological Services provide facilities, products, and distribution mechanisms to serve such specialized users as aviation, marine, space operations, agriculture, general military, and air pollution control.

BASIC METEOROLOGICAL SERVICE

Description

The Basic Meteorological Services provide fundamental observations and forecasts used by the general public, Departments and agencies of the Federal Government, and many segments of the economy.

The Basic Meteorological Service depends not only upon cooperative Federal efforts but also upon the cooperative efforts of the member Nations of the World Meteorological Organization. Four major Federal weather-observing programs--surface, upper air, radar, and weather satellites--are complemented by observations from other countries and provide the capability for detecting and tracking potentially hazardous weather and the essential data for basic analysis and prediction services.

Surface observations are made at fixed and mobile facilities on land and from ships and buoys at sea. The Department of Commerce's basic observing network is supplemented by observations from Defense's land installations and ships at sea, Coast Guard Stations and high endurance cutters, and selected FAA Towers and Flight Service Stations. For general synoptic-scale analysis and prediction, the land observational network over the conterminous United States is adequate for most purposes. At the present time, a limited number of automatic weather stations are used for essential observations from unmanned or inaccessible locations on land and sea. For example, two environmental buoys have been positioned off the middle-Atlantic coast to improve east coast winter storm and tropical cyclone forecasting. A buoy has been positioned in the Pacific southeast of Kodiak Island and another should be in place 200 miles southwest of Seattle by FY 1975. Other buoys are located in the Gulf of Mexico. Many more automatic weather stations and remote sensing techniques will be required to enhance the integrity of the surface observing network by filling gaps in remote areas, for moving in behind those agencies which curtail or close manned operations, and for small-scale observing networks in support of severe weather warnings.

The Basic Upper Air Observation Network (balloon) consists of a network of land and ship facilities operated by Commerce, with Defense and NASA participation at United States and overseas bases. There is a need for additional upper air observations, especially from the offshore areas of the Nation to help in improving the basic analysis, prediction, and warning services.

Commerce funds the meteorological programs aboard the Coast Guard operated and funded high endurance cutters manning Ocean Weather Station (OWS) HOTEL off the east coast, aboard government ships and in the U.S. Trust Territory of the Pacific Islands. The weather information provided by OWS

HOTEL in support of the east coast winter storms and tropical cyclone forecast program:

- Increases lead time for the preparation and dissemination of warnings.
- Reduces overwarning to reduce preparedness expenditures.
- Provides more precise analysis and forecasts, including coastal flooding and beach erosion.
- Provides data vital in developing and refining objective meteorological and oceanographic forecast techniques.

The Basic Upper Air Observation Network is supplemented in data-sparse areas by Defense weather reconnaissance flights, the Defense and NASA rocketsonde network, and in-flight aviation information reports.

Defense performs tropical cyclone aerial reconnaissance in the Western Pacific in response to military requirements and in the Eastern Pacific, Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico in accordance with the provisions of the *National Hurricane Operations Plan*. In addition, extratropical winter storm reconnaissance is flown in the western Atlantic in accordance with the provisions of the *National East Coast Winter Storms Operations Plan*. Defense aircraft also fly year-round weather and special storm reconnaissance missions over the ocean in the Northern Hemisphere and have a unique capability to partially fill the void of upper air data.

The Basic Weather Radar Network, comprised of specified Commerce and Defense radars along with FAA Air Traffic Control radars which are used to provide limited data from the western United States mountainous areas, is a major factor in the detection and tracking of significant weather events. Basic network radars are defined as those facilities with long-range detection capability manned for full 24-hour coverage and required to provide hourly observations. Within the umbrella of the long-range network radars, local warning radars serve as the basis for detailed short-period warnings and forecasts. For the most part, activation of local warning radars takes place upon notification of impending severe weather by the network radar facility. Currently, there are several gaps remaining in the basic network and there is a need for a large number of local warning radars to both replace outmoded World War II equipment and to expand coverage in those areas having frequent severe weather.

The new *Federal Plan for Weather Radars* states that NOAA plans to complete the primary network of long-range weather radars over the next 5 years by adding new radars in southern Virginia, east Texas, southern New York, western Nebraska, and eastern North Dakota and by establishing units to obtain information from FAA ARTCC radars at Denver and Anchorage. Sixty-six local-warning radars are proposed over the next few years to replace obsolete radars currently in operation and to provide data for other areas where the potential of severe weather is great. The Plan also states that NOAA proposes to add instrumentation to increase the usefulness of radar information.

Weather satellites are the fourth of the Basic Meteorological Service's programs for observations. There are two types of satellites--geostationary and polar orbiting--used to obtain information. Geostationary satellites are limited in geographical area coverage but provide data at frequent intervals essential to environmental warning services. Polar orbiters provide global data essential to basic environmental prediction services.

A prototype of the Geostationary Operational Environmental Satellite (GOES), NASA's SMS A, is scheduled to be launched during 1974. High resolution cloud pictures will be provided on a twice per hour basis from a position fixed above the earth. Because of the ability to detect and track severe weather, this satellite will be particularly useful in improving the ability to prepare timely and accurate warnings.

Work is beginning on a new generation polar orbiting satellite designated as Tiros N. Polar orbiters provide cloud imagery and vertical temperature profiles over the entire earth each day. Polar orbiters provide data, especially from remote areas of the globe, needed to improve environmental predictions.

More detailed descriptions of the satellite programs are found under "Weather Satellites", page 49.

Weather observations are collected and distributed nationally by teletypewriter systems operated by the FAA, Defense, and NOAA and internationally by specialized international and Defense weather communications systems linking the U.S. with overseas data sources. Using these observations, a forecast center prepares weather charts and forecasts for transmittal to specialized forecast centers, forecast offices, local weather offices, and other government and private users over NOAA and Defense facsimile systems.

The general public receives the weather forecasts and warnings through a variety of methods designed

to reach as much of the population as possible. The methods used include teletypewriter (e.g., NOAA Weather Wire Service, press wire services), recorded telephones, radio systems operated by NOAA and the Coast Guard, and through the mass media (radio, TV, and newspapers).

NOAA's National Meteorological Center (NMC) at Suitland, Md., provides basic analysis and forecast products for all Federal agencies, and industrial and commercial users. NMC is the source for hemispheric analyses and forecasts which provide the foundation for warnings of potential weather disasters and products issued by specialized services. Approximately 400 separate charts depicting analyses and forecasts of atmospheric conditions at various times in the future are issued each day. Emergency backup for NMC is provided by the Air Force Global Weather Central in accordance with the *Federal Plan for Cooperative Backup Among Operational Processing Centers*.

The NMC system is designed to prepare forecast guidance products required on a scheduled basis. There is an urgent need for centralized guidance between scheduled cycles in rapidly changing critical environmental situations. Also there is the need to modify the mathematical models to accept data on a non-scheduled basis to increase the use of satellite data in operational global prediction models. These needs have been partially satisfied by the addition of two advanced computers at Suitland, Md., which are shared by the NMC and the National Environmental Satellite Service. However, computers with increased computational ability will be needed in the future to cope with these problems. The *Federal Computer Plan for Operational Forecasting and Mathematical Modeling Research* is being updated. This document will reflect agency proposals for the acquisition and use of advanced generation computers.

Along with the need to increase capabilities at NMC, there is a need to increase the productivity and effectiveness of NOAA's field forecast services. Operational equipment will be implemented to increase automation in the field forecast services. The Automation of Field Operations and Services (AFOS) program has been developed to guide the implementation of automated techniques and equipment into the field forecast services. AFOS is a comprehensive program that encompasses the normal division of functions such as data acquisition, and forecast and warning preparation and dissemination. On-site mini-computers and TV-type displays are planned to provide assistance to the forecaster in data retrieval; forecast composition and monitoring; and data, forecast, and warning dissemination. Each of the WSFOs is proposed to be linked with each other and with the regional River Forecast Centers, the

AFOS Supervisory Console containing the mini-computer, disc storage, modems, and data archival tape units.

AFOS Forecasters Console. Alphanumeric and graphical products are displayed and forecasts and messages composed on the TV displays.

NMC, NHC, NSSFC, and the National Climatic Center. The linking circuit would be a full-duplex communications line of telephone quality, called the National Digital Circuit (NDC). Data would be circulated on the NDC at 2400 bits per second, increasing tremendously the communications capability of NOAA.

Each weather service forecast office is planned to have its own mini-computer to collect, process, display, communicate and disseminate information. The mini-computer enables the AFOS program to depart from previous trends in computerized data-handling by decentralizing computer capability rather than centralizing it. Through the use of its mini-computer, each WSFO would act as the collection point for all data acquired within its area of responsibility. It would store the data locally, and pass information along to other WSFOs and the regional and national weather centers by means of the National Digital Circuit. This rapid but dispersed data-handling system would also permit each office to act as a disseminating point for forecasts, warnings, and other information originating from anywhere within the NWS.

Each WSFO would have disc storage and display consoles with keyboards for calling up information from the data bank for both graphic and alpha-numeric display on the screen. There would also be a hard-copy device available for reproducing on paper any image in the data bank.

In 1975, initial implementation of AFOS should begin. Equipment is planned for 6 WSFOs, 1 RFC, 6 WSOs, the NMC interface and a system monitoring and coordination center.

In contrast to the day-to-day handling of weather data, analyses, and forecasts, the summarization of this data over long periods of time is taken care of within the climatological service. Climatology is the continuing use of historical weather data for long-range planning and to improve knowledge of weather and its effects upon life and property, and economic development. The *Federal Plan for National Climatic Services* (FCM 74-1, January 1974) presents in detail the activities and plans of the agencies of the Federal Government to improve the national climatic programs and services during the 1974-79 period. The primary purpose of the Plan is to make the application of climatological data to the problems of national economy and defense more effective. One of the more important steps planned for the next 5-year period is initiation of NOAA's computerized Environmental Data Index (ENDEX), which would provide rapid referal to interdisciplinary environmental data and their sources. ENDEX would be able to answer inquiries on environmental data availability for the continental United States by the end of 1974 and worldwide by 1978.

The operations and research programs for FY 1975, described in the following paragraphs, are directed toward improvement in weather forecasts. Table 5 lists the costs of the Basic Meteorological Service, by agency, for FY 1974 and 1975.

Operational Program for Fiscal Year 1975

The Department of Commerce's increased efforts in FY 1975 are designed primarily to enhance its severe weather detection and warning capabilities and to improve its efficiency through the use of automation.

Table 5.--Basic Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	194,454	197,820	10,912	11,085	205,366	208,905
Defense	39,540	38,343	.....	.....	39,540	38,343
NASA	.....	.....	33,653	36,540	33,653	36,540
Transportation:						
Coast Guard	5,127	2,120	.....	.....	5,127	2,120
FAA	8,479	8,389	.....	.....	8,479	8,389
Total	247,600	246,672	44,565	47,625	292,165	294,297

The Nation's basic weather radar network is planned to be expanded by the addition of a long-range radar to provide coverage of southern New York, an area hit hard by the Agnes storms. Also, the program begun in 1974 to replace outdated World War II surplus radars with modern equipment and fill major gaps in the basic radar network is planned to be continued. Twenty-five local warning radars are planned.

To increase our capability to detect and track hurricanes and severe storms over land areas, the first NOAA funded Geostationary Operational Environmental Satellite (GOES) is planned for launch. Continued procurement of GOES B and C is planned. Photorecorders are planned for 18 WSFOs to display the satellite pictures for use in providing warning services.

To help increase the hazard warning services to the Nation, it is planned to extend DOC's external dissemination system and improve individual and community preparedness in disaster-prone areas of the country. Ten additional states are planned to be served by the NOAA Weather Wire Service and 11 community preparedness specialists are planned to be stationed at weather offices to assist the local community in disaster preparedness planning.

Initial implementation of the Automation of Field Operations and Services (AFOS) is planned. This program will provide automated assistance to increase the efficiency of forecast operations. A system consisting of a mini-computer, storage, display terminals and communications equipment is planned to be installed at 6 WSFOs, 1 River Forecast Center, and 6 WSOs. Additional equipment needed for the NMC and the Systems Monitoring and Coordination Center (SMCC) are also planned.

The Department of Defense is planning additional reductions in its airborne weather reconnaissance force. However, the remaining reconnaissance force will be able to adequately meet the requirements for aerial reconnaissance of tropical cyclones and east coast winter storms that pose an immediate threat to the U.S. coasts. Defense is also improving their capability to exchange basic data between the U.S. and overseas.

Research Program for Fiscal Year 1975

Automation, improved new equipment, and selective expansion in observational facilities in conjunction with forecast improvement, especially in handling small scale, short term severe weather events, will receive emphasis in the FY 1975 research program for the Basic Meteorological Service. Advancements in automation technology represents the common thread weaving through many of these research activities. In particular, mini-computers are the key factor, since the trade-off between manual and automated handling and display of data, as contrasted with minimizing communications costs, allows much more effective expansion in service levels than could increases in manpower to achieve the same levels of service.

Automation is exemplified by the Department of Commerce's Automation of Field Operations and Services (AFOS) program which will receive a high level of R&D support as well as initial operational implementation (discussed earlier on page in this Plan). In concept, AFOS cuts across almost the entire service and functional structure of the National Weather Service. Its aim is to apply modern data-handling and display technology to the needs of field offices. AFOS research in FY 1975 will concentrate on the test bed Weather Service Forecast Office (WSFO) model facility to be located at the National Weather Service's headquarters in Silver Spring, Md., during FY 1974. This facility is planned to be expanded to include automation at the Weather Service Office (WSO) level. Experimental WSFO, WSO, and River Forecast Center (RFC) systems are planned to be installed in the field and at the National Meteorological Center (NMC) as an integral part of the model facility test bed. Experimentation will be conducted to validate the overall system design while the development of applications to utilize automation capabilities provided by AFOS will be stressed. Applications will fall into two categories -meteorological/hydrological and administration. As an example of meteorological applications, an automated aviation terminal forecast monitoring and updating system is planned to be developed and made operational.

Closely related automation efforts that will tie into the AFOS system include surface Automated Meteorological Observing Systems (AMOS) and a remotely operated counterpart, and the Digitized Radar Experiment (D/RADEX) and its corollary elements. Other equipment developments also based on automated assistance are those associated with a future next generation weather radar (NEXRAD 1) and the Next Generation Upper Air Sounding System (NEXAIR).

In the surface observing area, major Commerce efforts are devoted to developing modular automatic

weather observing stations for use at (1) sites where communications, power, and maintenance are available, and (2) remote unmanned sites where maintenance is difficult and communications and power are generally unavailable. In the first case, the AMOS III-70 has been developed. Plans for FY 1975 call for completion of the design and development on a follow-on to the AMOS III-70 that will observe more parameters for use at larger Weather Service Offices. The Remote Automatic Meteorological Observing System (RAMOS I) has been developed for unmanned sites. In FY 1975, all development and testing should be completed on a solid state wind sensor and a prevailing visibility sensor for use in hostile weather environments. These "next generation sensors" are used in both AMOS and RAMOS-type stations. Additionally, a prototype "substation" capable of automatically recording climatological data in monthly increments is planned to be developed, and test and evaluation begun.

Commerce plans to continue the Digitized/Radar Experiment (D/RADEX) during FY 1975. The major effort here will be to develop detailed specifications for the future field radar data processor (RADAP) system and to prepare the necessary operating software system. The RADAP system should ultimately be installed with all primary network radars and key local warning radars. Plans call for a test program to be conducted at a special test site in Pittsburgh, Pa., to integrate D/RADEX equipment and procedures into early field tests of the AFOS system. A number of experiments would be continued in efforts to apply digitized radar data to produce more complete observations of severe weather, including tornadoes, severe thunderstorms, and heavy rains that cause flash floods. In still another related effort, the Commerce Department plans to investigate and test potential components for a future next generation weather radar, called NEXRAD I.

During FY 1975 all development, test, and evaluation on the Next Generation Upper Air Sounding System (NEXAIR) land-based high-altitude system should be completed. This new system based upon the use of Omega navigation aids is designed to satisfy the requirements for wind, temperature, pressure, and humidity data during the late 1970s. A land system would be configured for a full field experiment. Also in FY 1975, experiments are planned to be conducted from a mobile van on such factors as geographical coverage and sferics. All development work should be completed on a frangible sonde and a "safe" battery for the sonde to eliminate any potential hazard to aircraft. At the same time, design and development is planned to be initiated on mobile accessories for NEXAIR.

For problems of probing the atmosphere, new devices for remote sensing of the distribution of wind, temperatures, and hydrometeors are occupying researchers in Commerce's Environmental Research Laboratories. Acoustic sounders, in which a pulse of acoustic energy is tracked by backscattered sound or by radar, promise to allow soundings of wind and temperature through the atmospheric boundary layer, and possibly through the troposphere. Laser radar (LIDAR) is already being used experimentally to measure cloud height and promises to allow remote measurement of wind circulation under clear weather conditions. When rain-drops or large cloud droplets are present to provide a tracer, new techniques of Doppler radar observations can measure the wind-flow patterns throughout a volume big enough to contain a mature thunderstorm or a tornado.

High priority will be given to field evaluation of the high frequency tornado detection system (based on measurement of burst rates of radio frequency atmospherics) including new direction-finding capabilities. Optical remote sensing will be expanded, including a new program of infrared Doppler measurements of the velocity field, for use in severe weather studies. In addition, work is planned to be conducted to profile transverse wind fields using optical scintillation techniques. A mobile LIDAR instrument, now undergoing field tests, is used to begin a systematic program to probe cloud height, cloud state, and drop sizes. New field observations are planned using a FM-CW radar system along with the new highly advanced dual-doppler radar systems to study the dynamics of clear-air convection, mountain winds, and thunderstorms.

In FY 1974 the National Meteorological Center (NMC) began development of an operational numerical hurricane model. NMC is initially interested in improving present forecasts associated with the 24-hour track of mature hurricanes; later goals are to predict the hurricane's development and precipitation patterns. During the first part of FY 1974, the basic numerical grid was constructed, the boundary layer physics, large scale latent heat release and convective adjustment as well as subgrid convection were incorporated into the model. The next phase is to incorporate this stationery model into the larger scale flow in order that the model may react with the

tropical environment. It is anticipated that this model will assist forecasters during the CY 1974 hurricane season.

As to techniques for forecast improvements, emphasis will be placed by DOC upon the severe local storms observations and forecasting research program at NOAA's National Severe Storms Laboratory (NSSL). Theoretical principles need to be validated by relating frequent observations to the development of realistic models of severe local storm processes and phenomena. Delineation of the fields of motion within convective storms by dual Doppler radar will be combined with coordinated observations from a network of surface, instrumented tower, upper air, radar, aircraft, and satellite systems. These will provide a comprehensive description and explanation of severe storm characteristics for a fundamental understanding leading to improved warnings and forecasts. Real time displays of the wind velocities obtained using the dual-Doppler radar system will be used for control of the observational program.

Objective techniques will be utilized for analyzing the observational data. Expanded physical-mathematical models and numerical vortex models will treat extremely complicated processes of condensation and precipitation and their interaction with the horizontal and vertical winds in tornadoes and severe storms.

An intensive effort will be made to apply digitized radar data to produce more accurate short range (less than six hours in advance) forecasts of such severe weather phenomena as tornadoes, thunderstorms, hail and damaging winds. In another phase of this work, an improved three-dimensional planetary boundary layer numerical model is planned to be developed for predicting temperature, humidity and wind within the lowest 2 km of the atmosphere. Output from this new model would serve as essential input to the development of more accurate severe weather forecasts over the next few years.

The Department of Commerce will also continue to emphasize development of better and more objective methods for making predictions of all weather elements used in public weather forecasts. Efforts will focus on improving automated forecasts for 254 cities in the continental United States. These efforts include:

- Amount of precipitation.
- Probability of precipitation.
- Probability of frozen precipitation.
- Amount of cloudiness.
- Surface temperature.
- Surface wind.

In addition, the first automated forecasts of surface dew point along with an expansion of surface temperature and probability of precipitation techniques to Alaska are planned.

AVIATION METEOROLOGICAL SERVICE

Description

The Aviation Meteorological Service furnishes specialized weather information to pilots, dispatchers, air traffic controllers, and fixed base operators to promote safety, efficiency, and operational effectiveness in civil and military aviation. Responsibility for the Service is shared among three Federal Departments--Commerce, Transportation, and Defense.

- The Department of Commerce provides meteorological services used by domestic and international civil aviation, and is responsible for meeting the common requirements of other agencies.
- The Department of Transportation makes recommendations to Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, disseminates weather information to users, and distributes weather data over civil teletypewriter systems.
- The Department of Defense serves the specialized global needs of military aviation and makes meteorological information from its facilities available to civil aviation.

Specialized surface observations, primarily in support of aviation, are made at 522 civil and military locations in the United States. On the civil side, Commerce provides these observations at 8 locations and the FAA at 347 locations. The remainder are provided by Defense. These figures do not include cooperative observations by private operators at many smaller airports and the many observations in support of the Basic Meteorological Service. At several locations the surface observation program is coordinated between Commerce and FAA or between Commerce or FAA and Defense.

Weather observations and other information in support of domestic civil aviation are collected and distributed over the FAA teletypewriter Service A and the Basic Meteorological Service teletypewriter systems. Defense agencies use the Continental United States Meteorological (COMET) teletypewriter

system to meet the needs of military aviation and ground units in the United States. Aviation meteorological data and information are exchanged internationally on the Aeronautical Fixed Telecommunications Network (AFTN) teletypewriter systems operated by FAA and on the high-speed systems of the Basic Meteorological Service. The Automated Weather Network (AWN) of Defense provides for high-speed collection and relay of data between overseas areas and the continental U.S. to meet Defense aviation and other military requirements; data from this system are provided to NMC as an essential ingredient to NMC's data base. NMC places selected North American data on the AWN for distribution to military users.

Analyses and forecasts for aviation are prepared by NOAA weather centrals, weather forecast offices, and weather service offices. As discussed later in the General Military Meteorological Services section, Defense operates 2 primary centers, 3 area guidance centers, and 2 specialized centers in the U.S. in support of military requirements.

National centers of the agencies provide national guidance and forecasts for use by lower echelon forecast offices. Cooperative Federal programs are conducted at the National Meteorological Center (NMC) of NOAA and at the Fleet Weather Central at Pearl Harbor, Hawaii. Private industries obtain meteorological products from the NMC over computer-to-computer links, at no cost to the Federal Government, for computerized flight planning. Defense prepares computer flight plans--an average of more than 1,200 daily--to support ort worldwide tactical and strategic aircraft movements. Arrangements are available as outlined in the *Federal Plan for Cooperative Backup for Aviation Winds Forecasts*, in the event a national center is inoperative.

Analysis and forecast centers of Commerce distribute specialized weather charts for aviation purposes to local weather offices and briefing facilities--Weather Service Offices (WSO), WSFOs FAA Flight Service Stations (FSS), and military offices--over the National and Aviation Facsimile Networks. Defense operates additional facsimile circuits to meet its specialized requirements.

Fifty NOAA WSFOs (including San Juan) prepare detailed local forecasts for 448 terminals and 303 routes on a scheduled basis, and six NOAA WSFOs provide forecasts for international civil aviation for the North Pacific, North Atlantic, and Caribbean areas and for Central America and West Europe according to procedures recommended by the International Civil Aviation Organization. Four Defense weather service offices also support international civil aviation in the interest of efficiency and economy.

Aviation weather briefings by the Departments of Commerce and Defense and FAA, are available to pilots through 641 manned and 181 unmanned remote controlled facilities. At the air terminals where a NOAA-WSO and an FAA-FSS are collocated, FSS personnel primarily handle the routine weather briefings. Users requiring more technical meteorological assistance are referred to the NOAA WSO or to the nearest WSFO. FAA has a telephone network linking airports that do not have a local weather briefing outlet to a nearby FSS. Pilots use this network to file flight plans and to obtain preflight weather briefings.

FAA has instituted a new service from four FSSs along the west coast which provides current weather conditions for flight information. This service, designated En Route Flight Advisory Service, receives and disseminates numerous pilot weather reports. Because of the success of this initial program, FAA plans to expand the service to cover all the conterminous States.

The FAA and NOAA are cooperating to provide aviation weather outlooks for weekend flying over the Public Broadcast System Television Stations. Since the inception at a Baltimore station a little more than a year ago, a tremendous expansion of the program has occurred. Now approximately 120 stations air this show.

Voice communications systems are used widely in the Aviation Meteorological Service by FAA and Defense. The FAA air-ground radio systems are used to provide weather information to and obtain data from pilots. Weather observations, forecasts, and advisories are carried as scheduled broadcasts on over 800 air navigation aids and as continuous transcribed weather broadcasts for 104 radio outlets. The Pilots Automatic Telephone Weather Answering Service (PATWAS) provides forecasts covering a 250-mile radius at 60 locations, plus 10 additional locations that cover the local areas only. Airborne pilots can receive a weather briefing by radio contact with an FSS. The Department of Defense operates a network of air-ground radio facilities to provide observations, forecasts, and warnings on request to airborne military pilots and to obtain in-flight weather reports from military aircraft.

As evidence of the magnitude of aviation services

provided each year, the FAA provides over 13 million pilot weather briefings and NOAA about 2 million. Defense prepares approximately 2 million detailed flight weather briefings at its worldwide terminals.

Improvements in Aviation Weather Services are needed to meet the demand for increased services. NOAA's AFOS program and the FAA's Automated Flight Service Station program will help by providing automated briefings and forecast monitoring to free the forecaster and briefer to concentrate on the more pressing weather areas.

These programs will also help to meet essential Defense and FAA unmet common requirements for continuous updating and improvements of forecasts of ceiling, precipitation, fisibility, wind velocity, temperature, slant range visibility, and wind shear for use in aircraft operations. To meet these needs, techniques are required to provide the following:

- Runway visual range measurements at 100-foot increments down to zero visibility.
- Slant range visibility.
- Low-level wind shear including wake turbulence vortexes.
- Automatic measurements of cloud height and amount.
- Automatic measurements of prevailing visibility.

Table 6 lists the costs of the Aviation Meteorological Service, by agency, for FY 1974-75.

Operational Program for Fiscal Year 1975

The FAA has a continuing program to improve service to the aviation community by increasing the number of facilities that make weather observations and installing additional meteorological measuring equipment (e.g., rotating beam ceilometers, hygrothermometers, and runway visual range units). The FAA also plans to purchase and install additional equipment for providing continuous broadcast of weather information and to expand its En Route Flight Advisory Service to enhance the safety of flight operations.

The Department of Defense shows reduced overall funding for FY 1975. Continued reduction in force plus the completion in FY 1974 of a number of programs started in earlier years accounts for this funding decrease. Offsetting some of these reductions, Defense is upgrading its computer capabilities at the Air Force Global Weather Central.

Research Program for Fiscal Year 1975

The Department of Commerce is continuing research directed toward improving methods for observations of visibility, cloud cover, cloud height, and freezing rain, using current sensor technology. Under this shorter range work, a backscatter visibility sensor has already been successfully tested, and shows great promise as an automatic sensor capable of operating even in the extremely cold temperatures found in Alaska. For cloud height measurements, an eye-safe lidar ceilometer is being tested. In still another related effort, an aircraft ice accretion rate sensor has been successfully field tested for use in detecting freezing rain which can be hazardous to aircraft operations. In FY 1975, the foregoing visibility, cloud and freezing rain sensors are planned to be incorporated into existing automatic weather stations. For the longer-range work, efforts are being made to determine the most promising future visibility, cloud, and precipitation sensors and observing techniques for an eventual complete automation of

Table 6.--Aviation Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	18,039	18,039	300	300	18,339	18,339
Defense	110,250	104,532	842	800	111,092	105,332
Transportation:						
Coast Guard	599	267	.....	.....	599	267
FAA	43,641	51,847	7,873	7,700	51,514	59,547
Total	172,529	174,685	9,015	8,800	181,544	183,485

aviation observations. An infrared (IR) cloud measurement system is planned to be developed that would be incorporated into an automatic, objective observation technique for detecting cloud heights.

As part of the AFOS program mentioned previously, automated techniques for terminal forecasts and monitoring terminal forecasts are being developed.

The Department of Defense research effort continues to be oriented toward specific military requirements. Operation and data gathering from the mesoscale observing network near Bedford, Mass., will continue. With the use of this data, quantitatively better forecasting procedures for short-period terminal forecasting are being developed. Work continues on the development of techniques for dissipating warm and cold fogs at small, advanced airfields, especially those used by helicopters in resupply and rescue operations. Instruments and techniques designed to support land- and sea-based aviation operations will receive continuing attention.

The aviation weather research program of the Department of Transportation is designed to provide the technical and operational developments that will improve performance and use of existing components of weather acquisition, transfer, processing, and display equipment. The objective is to modify these specific components for integration into the modernized configuration of the National Airspace System. In this program, the FAA will continue to develop improved techniques for hazardous weather and turbulence detection. By using Doppler radar and other detection devices, the FAA will evaluate techniques for detecting and predicting clear air turbulence (CAT). Automated methods for improving the accuracy, timeliness, and reliability of aviation terminal forecasts will be sought.

In addition, the FAA plans to investigate (1) methods of improving pilot briefings at FSSs and using automatic data processing techniques for briefing pilots, (2) the use of an acoustic Doppler sounder for low-level wind measurements, (3) methods of providing improved visibility and slant visibility assessment, and (4) plans to conduct research on alleviating the effects of aircraft wake turbulence.

MARINE METEOROLOGICAL SERVICE

Description

The Departments of Commerce, Transportation, and Defense share statutory responsibility for the Marine Meteorological Service, designed to promote the efficiency of civil and military marine operations and to insure the safety of life and property at sea and on coastal and inland waters. Many segments of the economy--including transoceanic, coastal, and Great Lakes shipping, commercial fishing, offshore drilling and mining, deep port activities, and recreational boating--urgently need detailed forecasts of winds, sea and swell, surf and breakers, ice conditions, anomalous water levels, sea surface temperature, and ocean current regimes.

- The Department of Commerce is responsible for collecting observations, issuing forecasts and warnings, and disseminating marine meteorological information to benefit marine industry navigation, and the general boating public.
- The Coast Guard is responsible for assisting Commerce with observations, warnings, and weather information on the high seas and waters over which the United States has jurisdiction.
- The Department of Defense is responsible for providing marine meteorological information to its forces.

Marine meteorological observations provided or supported by Commerce include those from the cooperative ship program, the tide and wave gage network, the cooperative hurricane observation network, data buoys, and satellites.

While at sea, major commissioned vessels of the Navy make weather reports that supplement observations largely supplied by the Basic Meteorological Service. Twenty-six naval vessels have sophisticated equipment for more detailed surface observations, with 22 of these equipped to make upper air observations. Naval observations are made available to other Federal agencies through routine data collection and exchange. In addition, all large Coast Guard cutters make weather reports at sea, and 23 Coast Guard cutters are equipped with balloon inflation shelters for making upper air observations.

Commerce supplements the analysis and forecasting functions of the Basic Meteorological Service with specialized marine support operations at a number of its Weather Service Forecast Offices (WSFO). The Marine Forecast Unit at WSFO Anchorage, Alaska, provides marine support in Alaskan waters, including the Gulf of Alaska and the Bering, Chukchi, and Beaufort Seas. Particular attention is given to sea ice and its effect on shipping and drilling. The Marine Forecast Unit at WSFO San Francisco operates an expanded marine environmental service

program in cooperation with the Coast Guard. Weather and sea forecasts and warnings are provided 8 hours a day by radiofacsimile, voice, and Morse telegraphy from the Coast Guard radio station at Point Reyes, Calif. Marine Forecast Units at WSFO Honolulu, NHC Miami, and WSFO Washington provide high seas marine services in the central tropical Pacific and the western North Atlantic, where the United States is responsible for shipping forecasts and warnings under the Safety of Life and Sea Conventions and the World Meteorological Organization. In the extreme western North Pacific, Defense provides those services. Marine forecasts and warnings are issued by 18 WSFOs for coastal and offshore waters and by 3 WSFOs for the Great Lakes. Twenty-nine other WSFOs serve recreational boaters for lakes and waterways within their area of responsibility as part of the public forecast program. The Great Lakes weather and ice service program is being substantially aided by resources of the Great Lakes and St. Lawrence Seaway Navigation Season Extension Demonstration Program, which is managed by Defense's Corps of Engineers.

Four Fleet Weather Centrals supplement the broad-scale products from the Navy's Fleet Numerical Weather Central (FNWC) and NOAA's National Meteorological Center (NMC) by preparing detailed analyses, forecasts, and warnings for their assigned areas of responsibility. In addition, FNWC and one of the Fleet Weather Centrals provide optimum-track ship routing services to naval vessels and commercial ships operating under Department of Defense contract.

Dissemination channels provided by Commerce for weather information and warnings in coastal areas and the Great Lakes include VHF-FM radio broadcasts, messages over the NOAA Weather Wire, and recorded telephone forecasts.

A special service for high-seas shipping is provided by NOAA in cooperation with the National Bureau of Standards, using the time-signal broadcast facilities of WWV (Colorado) and WWVH (Hawaii). It consists of three brief 45-second broadcasts each hour, giving information on major storms in the North Atlantic and the North and South Pacific. Facsimile service from Coast Guard and Defense radio broadcasts is available to specially equipped ships. All Defense naval broadcasts--radio-teletypewriter, voice, and facsimile--are primarily to support naval forces and are subject to change in schedule and content on minimum notice.

Personal marine briefing services are available at all WSFOs having marine service programs; however, most users rely on the various communications systems or on the Coastal Warning System for their information. The latter system is a cooperative network of about 450 visual (flag and light) signals at prominent locations along the coasts, Great Lakes, and inland waterways to advise marine interests when warnings are in effect. The Coast Guard and NOAA operate about one-half of these displays. Non-Federal interests operate the remainder. More than 100 Defense weather offices at shore stations and aboard larger ships provide marine briefing services in support of naval operations.

Naval units supplement the Basic Meteorological Service data collection, distribution, and dissemination systems by transmitting weather information along with other traffic on Defense communications systems. In addition, the Naval Environmental Data Network provides for computer-to-computer distribution of products from the FNWC to other Fleet Weather Centrals and Facilities in the United States and overseas areas.

The *Federal Plan for Marine Environmental Prediction* provides greater detail on the total Marine Meteorological Services.

Table 7 lists the costs of the Marine Meteorological Service, by agency, for FY 1974 and FY 1975.

Operational Program for Fiscal Year 1975

The Department of Defense (Navy) is making a number of adjustments in its program to serve the fleet most of which are to expand the use of satellite observations. Other agencies are maintaining the service at about the same levels as in previous years.

Research Program for Fiscal Year 1975

The Department of Commerce is continuing to emphasize development of automated techniques for producing marine environmental observations and forecasts for oceanic areas, coastal areas, and the Great Lakes. Included is the research, development, test, and evaluation of buoy components and systems that can withstand the severe ocean environment. The buoy program of about $5 million is described and accounted for in the *Federal Plan for Marine Environmental Prediction*. Studies are planned on air-sea interaction and the coupling of ocean-atmosphere processes.

Models which have been developed for forecasting storm surge from both tropical and extratropical

Table 7.--Marine Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	1,653	1,653	150	150	1,803	1,803
Defense	8,089	9,194	871	1,214	8,960	10,408
Transportation:						
Coast Guard	807	420	.....	.....	807	420
Total	10,549	11,267	1,021	1,364	11,570	12,631

storms are to be tailored for local topography and shape of shoreline. Also, an objective, automated system is under development for forecasting winds at eight light ship stations along the east coast from Cape Hatteras, N.C., to Portland, Maine. For the Great Lakes, automated wave forecasts will undergo further test and evaluation.

The Department of Defense is continuing the development of analysis and prediction models and of techniques to provide a global, automated prediction system. The system would collect, process, disseminate, and display environmental information for use in problems unique to military operations on a near real-time basis. The overall objective is a total system that will, through automatic data processing techniques, process and analyze raw data from land-based, shipboard, airborne, buoy, and satellite meteorological- and oceanographic-measuring systems. Command estimates of the prospective success of environmentally sensitive military operations may then be made by using accurate environmental predictions and interpretations which are derived from advanced data processing and analysis techniques that use air- and sea-coupled mathematical models.

SPACE OPERATIONS METEOROLOGICAL SERVICE

Description

The Space Operations Meteorological Service provides the specialized weather information required to plan and conduct the Nation's space and missile program. Although the participation of the agencies involved--NASA, DOC, and DOD--vary in degree among the programs, the general responsibilities are as follows. DOC, under a number of reimbursable agreements with NASA and DOD, is responsible for:

- Operational forecasting and observations in support of manned space flights and unmanned earth resources space vehicles.
- Staff support at the NASA space centers.

DOD provides this service for the:

- Eastern Test Range
- Space and Missile Test Center
- Pacific Missile Range

Particularly in the service to manned space flights, there must be weather surveillance and forecasting for large areas of the world to provide for the planned and the many possible emergency landing areas and to assist in scheduling earth-sensing experiments. Meteorological satellite products are extensively used to provide the Space Operations Meteorological Service, especially for the remote ocean areas of both hemispheres.

The DOC supports a variety of NASA programs under a number of reimbursable agreements. There are NWS teams at NASA facilities at the Wallops Station, Wallops Island, Va., the J.F. Kennedy Space Center, Fla., and the Lyndon B. Johnson Space Center, Houston, Tex. The staff at Houston is aided by meteorologists at the NWS National Meteorological Center, the NOAA National Environmental Satellite Service, and NWS offices in Miami and Honolulu. The effort ranges from support studies to participation in flight missions, with exacting weather requirements for launch and recovery.

The Department of Defense provides the Space Operations Meteorological Service for the Eastern Test Range, the Space and Missile Test Center, and the Pacific Missile Range. Networks of surface,

radiosonde, and weather radar stations are located on islands and on ships stationed within the Ranges. Specialized staffs at Range Weather Stations provide weather forecasts and planning studies. Defense personnel provide observations through contracts with private industry or through funding agreements with Commerce. Defense also provides for participation in the Meteorological Rocket Network formed to gather atmospheric data from 30 to 110 kilometers above the earth as required by Defense, NASA, and Commerce for missile, space exploration, atmospheric research, and nuclear effects research projects. Meteorological support is also provided to the White Sands, N. Mex., and Kwajalein Missile Ranges and to other Defense research and testing facilities.

Launch sites, missile test ranges, and sometimes recovery areas are instrumented by the user agency to yield weather information from the earth's surface to an altitude of about 60 kilometers. This information is needed to determine the conditions that missiles and space vehicles will encounter either at launch or upon reentry into the atmosphere.

Weather observations from local, national, and international networks are used along with weather radar, satellite, and aircraft reconnaissance data as a basis for forecasts and warnings of weather that might affect launch or landing and recovery.

Table 8 lists the costs of the Space Operations Meteorological Service by agency, for FY 1974 and FY 1975.

Operational Program for Fiscal Year 1975

There are no significant changes in this program. The Departments concerned are continuing their efforts to improve the service within available resources.

Research Program for Fiscal Year 1975

Defense has a continuing program for the development of improved meteorological instrumentation to meet the specialized needs of both the Eastern Test Range and the Space and Missile Test Center. Specialized instrumentation and data are used to assist in scheduling launch operations, in evaluating missile and payload flight performance, in making reentry calculations, and in insuring range safety.

As part of the supporting research program, Defense and NASA are improving rockets and rocket-borne instruments and are investigating upper atmospheric phenomena through use of rocket data. The NWS teams supporting the NASA manned space programs operationally also conduct a variety of studies oriented toward mission planning and toward development of forecasting techniques for future flights.

AGRICULTURE METEOROLOGICAL SERVICE

Description

The Agriculture Meteorological Service, which includes the Agricultural and Fruit-Frost Weather Services, provides specialized observations, forecasts, and warnings to the agricultural community. A detailed description of this service is described in the *Federal Plan for a National Agricultural Weather Service*.

The Departments of Commerce and Agriculture are responsible for the provision of the country's agricultural weather services. DOC has the responsibility for:

- Planning the service.
- Conducting the service.

Table 8.--Space Operations Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Defense	7,339	6,966	300	200	7,639	7,166
NASA	1,523	1,322	.....	.....	1,523	1,322
Total	8,862	8,288	300	200	9,162	8,488

Accurate forecasts are needed when grapes are laid out to dry into raisons, in California.

The Department of Agriculture:

- Funds and carries out the supporting research.
- Assists in planning.
- Cooperates in observing, communicating, and distributing meteorological information.

Specialized observation networks are maintained in agricultural areas away from the normal observing sites in or near urban areas. In most cases, observations are on a cooperative basis between NOAA and other Federal and State agencies or private interests. Thousands of private citizens serving without pay provide daily measurements of air and soil temperatures, rainfall, and evaporation in crop areas. Observers for Federal and State agencies at agricultural experiment stations, colleges, and universities obtain detailed micrometeorological data for studying agriculture-meteorology relations.

The NOAA Weather Wire Service disseminates forecasts, warnings, and advisories to users and to the mass media in each of the 12 service areas available to the national Agricultural Weather Service.

Forecasts for agricultural users--ranging from a short-period forecast which affects planting, harvesting, crop dusting, and spraying to a 30-day outlook for general agricultural planning--are prepared at Commerce Weather Service Forecast Offices in each of the 12 agricultural service areas. Interpretive and consulting services are provided by advisory agricultural meteorologists from 18 Weather Service Offices (Agriculture) at Federal and State experiment stations. A well-received service for wool growers and livestock producers in Wyoming and North and South Dakota makes recorded forecasts and warnings continuously available by telephone from mid-October to mid-May.

In an effort to improve the Agriculture Weather Service within existing resources, a new facility, designated as the Environmental Study Service Center, was established at Auburn, Ala., in FY 1974. This center will provide the following functions for the States of Alabama, Georgia, and Florida:

- Advisory agricultural meteorology program.
- Technical studies relating weather to agriculture.
- Consulting services for agricultural research efforts.
- Liaison services with agricultural organizations and users.

The Agricultural Meteorological Service provides advisory and extension services and improved weather forecasts for agricultural management and decision-making in all the Nation's principal agricultural areas. These specialized services are not yet available in all areas where needed, and in many remote rural areas appropriate meteorological sensors are lacking.

Table 9 lists the costs of the Agricultural Meteorological Service, by agency, for FY 1974-75.

Table 9.--Agricultural Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Agriculture	.....	.....	943	1,033	943	1,033
Commerce	2,249	2,249	.....	.....	2,249	2,249
Total	2,249	2,249	943	1,033	3,192	3,282

Operational Program for Fiscal Year 1975

In FY 1975 the Department of Commerce will continue to improve its service to the agricultural interests through improved cross utilization of its forecasters and expanded dissemination systems. Also, an Environmental Study Service Center similar to the one at Auburn, Ala., is planned for implementation at Stoneville, Miss., through reprogramming action. This center would be responsible for agricultural weather services in the states of Arkansas, Louisiana, Tennessee, and Mississippi.

Research Program for Fiscal Year 1975

The Department of Agriculture funds the supporting research program. Studies are being conducted on the effect of climatic factors on various insect species and on better uses for beneficial species. Basic studies are being conducted to determine the relationship between climate and such factors as crop hardiness, quality, productiveness and drought resistance. The Department is directing a national research program on plant disease epidemiology and forecasting in which extensive use is made of micrometeorological data observed at the plant level. Studies are being performed to determine the action of air pollutants on plants and methods of controlling the damage. Investigations are being carried out to determine the potential economic and institutional considerations of suppressing hail and the effects of weather on foreign crop production.

GENERAL MILITARY METEOROLOGICAL SERVICE

Description

The Department of Defense requires worldwide meteorological support tailored to specific military requirements. The General Military Meteorological Service provides military users with support not available from the Basic Meteorological Service or from other Specialized Meteorological Services. Support for specific users, such as aviation, marine, and space operations, is covered in the sections on the relevant Specialized Meteorological Services.

Requirements of military users include: meteorological information specific to the particular weapons system being developed or employed; unique forecasts and analyses for command and control systems; specialized information such as ballistic data; specialized forecasts, impact prediction, meteorological advisory services, and post-test analysis assistance to research, development, test, and evaluation sites; and general meteorological support for training and deployment of military forces and contingency operations.

Hence, various elements of Defense require special meteorological services. To provide them, the Department maintains analysis and forecasting facilities in the United States and abroad. Defense operates the Air Force Global Weather Central (AFGWC) at Offutt Air Force Base, Nebr., the Fleet Numerical Weather Central (FNWC) at Monterey, Calif., and forecast centers in Europe, the Pacific, and the Far East. Specialized centers--such as the Air Force Environmental Technical Applications Center (USAF ETAC) at Washington and the Joint Typhoon Warning Center at Guam--also fulfill unique military meteorological requirements. Similarly, Defense observation facilities are operated to obtain data in direct support of military operations. Military communications networks are maintained to collect and exchange observations and to disseminate forecasts. Whenever possible, these observations are made available to other Federal agencies.

Also, the Defense aerial weather reconnaissance plays a vital role in specific Defense operations. It provides weather observations for refueling, tactical deployments, and contingency exercises, wind information for mass airdrop exercises, tropical cyclone observations, and weather observations in missile recovery areas. For meteorological support to tactical operations, the Department uses air-transportable van complexes.

Table 10 lists the costs of the General Military Meteorological Service for FY 1974-75.

Operational Program for Fiscal Year 1975

The total program for this service reflects little change. Reductions in force structure account for some budget reductions and completion of some programs during FY 1974 account for additional reductions. These reductions are offset by the upgrading of the computer capabilities at both the Fleet Numerical Weather Central and the Air Global Weather Central which, in part, will provide improved services to general military activities.

Research Program for Fiscal Year 1975

All military research programs are designed to meet

Table 10.--General Military Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Defense:						
Army	5,367	5,786	9,040	10,732	14,407	16,518
Navy	6,848	7,634	1,308	1,821	8,156	9,455
Air Force	23,075	21,459	3,264	3,407	26,339	24,866
Total	35,290	34,879	13,612	15,960	48,902	50,839

the unique requirements of the Department of Defense. Other Government agencies benefit from this research. The Department's research programs have been categorized and discussed under previous subsections of the Plan as research directed toward improvements in a specific Service (e.g., Aviation Meteorological Service). These programs are also considered as research in support of the General Military Meteorological Service because they are directed toward improvements in meteorological support to the overall Defense mission.

The specific objectives of the Department in meteorological research include the following:

- Improvement of the means for meteorological data management, including the collection, dissemination, evaluation, processing, storage, retrieval, display, and quality control of meteorological data and the processing of static data into meaningful and necessary predictions of meteorological conditions.
- Provisions for near real-time meteorological support to weapons systems and tactical operations by the development of new systems such as the Meteorological Data Sounding System AN/UMQ-7(V) and the Automatic Meteorological System (AMS). The AMS is being designed to receive, organize, integrate, and provide the numerous meteorological data (such as those obtained through standard observation, meteorological satellites, and remote sensing devices) in the specific form required by the user (aviation, artillery, combat commander) on a near real-time basis.
- Identification of the impact of environmental conditions on weapons systems and military operations.
- Determination of the atmospheric effects on transmission, refraction, and scattering of acoustic and electromagnetic energy and on dissemination of aerosols and radioactive fallout.
- Rapid conversion of meteorological information into such terms as may be useful to, or required by, operational commanders or be useful in the operation of weapons systems.
- Improvement of weather observations, analysis, and prediction. Automatic observing and reporting systems for rapid, accurate observations of meteorological parameters are required. Improvements are also necessary in the unique observation equipment to support land- and sea-based aircraft operations. Computerized systems for analyzing data and for providing accurate long-range weather predictions are required for all regions of the earth. Particular emphasis is placed on extending the present capabilities of prediction to the tropics, Arctic regions, and the Southern Hemisphere as well as local weather forecasts.
- Development of techniques and methods by which observations from mesoscale surface networks may be used to increase the accuracy of terminal forecasts.

FIRE WEATHER AND AIR QUALITY METEOROLOGICAL SERVICES

Description

Recent shortages of lumber and wood products and the conflict between critical energy needs and air quality standards highlight the stresses being placed on the Nation's forest and air resources. Federal, State, and local agencies charged with protection and

maintenance of these resources depend on reliable meteorological data and forecasts. Although the Fire Weather and Air Quality Meteorological Services are provided primarily for forested and urban areas, respectively, growing use of controlled burning in forest and agricultural management provides a meeting ground for the users and services.

FIRE WEATHER SERVICE

The Department of Commerce through NOAA's National Weather Service has the responsibility for fire weather forecasting. The Forest Service of the Department of Agriculture and the Bureau of Land Management of the Department of Interior, along with the State forest agencies contribute to the Fire Weather Service by supplying fire weather observations for some 2,000 locations scattered through the State and National Forests.

Broad-scale forecast guidance is provided by NOAA's National Meteorological Center. Forecasts for fire weather users--ranging from 5-day extended and 36- to 48-hour general forecasts of weather patterns and elements, such as winds, temperature, rainfall, humidity, and fuel moisture to short-period forecasts for a specific forest fire or warnings of unusually high fire danger in a forest--are prepared at 51 selected Weather Service Forecast and Weather Service Offices by fire weather specialists. These offices prepare detailed forecasts for local users within their assigned forest districts. Twenty-three truck-mounted mobile units, equipped with two-way radio and radio facsimile, deploy to major forest fires to provide immediate on-site observation and forecast support to firefighting crews.

Forest fire fighters in western United States require close weather support.

AIR QUALITY METEORLOGICAL SERVICE

Over 70 percent of the Nation's population is concentrated in some 200 urban areas with less than 10 percent of the country's land area. Solution of the continuing air pollution problem associated with urbanization demands the coordinated efforts of Federal, State, and local governments. The Air Quality Meteorological Service provides essential meteorological data and forecasts to Federal, State, and local governmental agencies responsible for dealing with urban air pollution and advises the public of weather conditions that may lead to serious air pollution episodes.

The Department of Commerce has the responsibility for this service while the Environmental Protection Agency handles air quality research in support of the service.

The Department of Commerce's responsibilities include the surface and upper air observations necessary to describe the weather in urban areas, air stagnation forecasts in sufficient detail to provide the basis for air pollution control decisions, and applied research to improve these observations and forecasts. The operational responsibilities are discharged in Commerce by its Air Quality Meteorological Service which consists of 52 Air Stagnation Advisory Offices, 14 of which are staffed with specially trained air pollution meteorologists and six that provide meteorological advisory service for smoke management. The applied research is accomplished principally by NOAA personnel assigned to the Environmental Protection Agency's (EPA) Meteorology Laboratory.

The Air Quality Meteorological Service must (1) establish and maintain weather service support to urban regions where the threat of critical air pollution episodes still exists, and (2) increase the timeliness, lead time, and accuracy of air pollution weather forecasts.

In addition to the Air Quality Meteorological Services provided and programmed for selected urban areas, the Environmental Protection Agency has expressed the view that additional forecasting services may be required in nonurban areas to predict conditions that are not conducive to the rapid dispersion of smoke generated by agricultural and

Denver, Colorado—A major metropolitan area experiences serious air pollution.

forest slash burning. EPA is responsible for working with State and local governmental agencies to insure adequate meteorological support programs. These services are specified in the *Federal Plan for Air Pollution Control Meteorological Service*.

Table 11 lists the costs of the Fire Weather and Air Quality Meteorological Service, by agency, for FY 1974-75.

Operational Program for Fiscal Year 1975

The Department of Commerce is continuing to improve its services through cross utilization of WSFO forecasters and expanded dissemination systems.

Research Program for Fiscal Year 1975

The research program of the Environmental Protection Agency is in direct support of mission functions and is primarily concerned with solving high-priority problems in connection with establishing and enforcing pollution control regulations.

A major thrust of current and proposed atmospheric research seeks to provide objective tools for use in the development of least-cost pollution control strategies, land use and transportation planning for pollution control, pollution episode forecasting and control, and as aids to pollution monitoring networks. The development of air quality simulation models will permit EPA to describe and evaluate the impact of air pollution on urban and nonurban environments, and provide quantitative description of the impact of air pollution on weather, visibility, and climate.

The remaining research funds are directed toward defining air pollution on a regional scale and providing the basic input data for development of descriptive simulation models. Research activities also

Table 11.--Fire Weather and Air Quality Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
EPA	600	.....	8,430	8,430	9,030	8,430
NASA	.....	.....	60	77	60	77
Commerce	3,003	3,003	.....	.....	3,003	3,003
Total	3,603	3,003	8,490	8,507	12,093	11,510

include technical support to urban health problems (Community Health Environmental Surveillance Studies) and research directed toward defining trends in urban and rural air pollution.

Other research activities include administration of a 75-site network for monitoring atmospheric turbidity for assessing trends in global pollution. A major activity includes the Regional Air Pollution Study (RAPS) in St. Louis, Mo., which will provide a scientific data base to develop, evaluate, and validate air quality simulation models for assessing air pollution strategies on a regional basis. Part of the increase in observation funds starting in FY 1973 is the result of establishing and maintaining 25 new stations to support the regional investigations and 25 new stations related to urban health research.

OTHER SPECIALIZED METEOROLOGICAL SERVICES

Description

Several Federal agencies and user groups vitally need other specialized meteorological services. In general, these are either supporting weather services for research and development or operational activities not large enough to warrant a separate service category. These meteorological service programs generally support stable, ongoing activities in which year-to-year changes are usually small. The programs included are:

- The Department of Defense programs for meteorological support of civil works projects and to some of its research, development, test, and evaluation activities such as equipment design and testing, geophysical laboratories support, and polar research operations.
- The Atomic Energy Commission (AEC) programs for meteorological support of its laboratories and test sites.

Table 12 lists the operational costs of the Other Specialized Meteorological Services, by agency, for FY 1974-75.

Operational Program for Fiscal Year 1975

These specialized meteorological services support relatively stable programs and so little change is indicated.

Research Program for Fiscal Year 1975

The AEC research program includes an important element which provides support for a large and changing operational program. This support consists of the evaluation and prediction of atmospheric transport and diffusion and of atmospheric cleansing mechanisms such as deposition and washout.

Supporting research for reactor tests includes studies of mesometeorological motions and dilution patterns predicted by a mathematical model and verified with tracer experiments. The motion and dilution of effluents in the immediate wake of large structures is evaluated with field and wind tunnel tests.

The evaluation of safety aspects associated with the transport and storage of nuclear supply systems for space missions requires studies of the movement and composition of aerosol and gaseous radioactive materials extending from the earth's surface to orbital reentry altitudes.

Measurements and supporting studies are necessary for assessing the environmental impact of numerous postulated Commission experiments including underground testing of nuclear devices and atmospheric testing of nuclear rockets. Meteorological data are collected to permit the assessment of the effect of these variables on the relocation of aerosols previously deposited on the ground. A broad variety of modeling is accomplished for application to studies of the long-range effects of various peaceful uses of nuclear explosives.

Table 12.--Other Specialized Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
AEC	1,757	1,893	429	470	2,186	2,363
Defense	10,116	9,765	.....	.....	10,116	9,765
Total	11,873	11,658	429	470	12,302	12,128

Operational Functions

INTRODUCTION

Five distinct functions are common to all Basic and Specialized Meteorological Services. These are observations, analyses and forecasts, communications, dissemination to users, and general agency support. The Federal operations for each of these functions are described in this section of the Plan. Following each description are the program changes for FY 1975 as projected by the agencies to meet the Federal goals. Table 13 lists the agency operational costs, by function, and table 14 lists the agency manpower engaged in weather operations, by function, for FY 1974-75. Agency research programs are described in the Services section of this Plan and are not repeated here. However, table 15 lists the agency supporting research costs, by function, for FY 1974-75.

OBSERVATIONS

Description

Meteorological observations are the raw material of all weather service. Observations are of such fundamental importance to all meteorological organizations, public and private alike, that nearly every aspect of the observing and reporting process is regulated by international agreement. These agreements recognize five basic categories of observation:

- Surface observations of pressure, temperature, humidity, wind, cloud, and visual range.
- Upper air observations of pressure, temperature, humidity, and wind made by balloon, aircraft, or rocket above a point.
- Aircraft reconnaissance observations in which the upper air elements are measured at many points along a track at flight level and pressure, temperature, and humidity are measured by dropsonde between flight level and the surface at a few points along the track.
- Weather radar observations which detect the presence and motion of hydrometeors in a volume of the atmosphere.
- Weather satellite observations of cloud patterns

Table 13.--Agency operational costs, by function
(Thousands of dollars)

Agency	Observations		Analyses and forecasts		Communications		Dissemination to users		General agency support		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
AEC	860	927	.....	.....	18	19	123	133	756	814	1,757	1,893
Commerce	91,819	90,493	55,142	55,142	8,506	8,506	21,872	26,564	42,059	42,059	219,398	222,764
Defense	86,975	72,406	28,258	33,359	20,110	20,652	31,750	31,834	43,531	45,428	210,624	203,679
EPA	150	.....	150	.....	.....	.....	100	.....	200	.....	600	.....
NASA	262	224	587	524	68	70	76	82	530	422	1,523	1,322
Transportation:												
Coast Guard .	5,590	2,247	.....	.....	209	208	602	210	132	142	6,533	2,807
FAA	7,075	10,907	149	157	17,651	18,075	15,728	18,256	11,517	12,841	52,120	60,236
Total	192,731	177,204	84,286	89,182	46,562	47,530	70,251	77,079	98,725	101,706	492,555	492,701

Table 14.–Agency manpower engaged in weather operations, by function

Agency	Observations		Analyses and forecasts		Communications		Dissemination to users		General agency support		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	1,835	1,839	1,738	1,738	190	190	932	989	1,505	1,505	6,200	6,261
(1)	80	78	50	50	.....	.....	.....	.....	16	20	146	148
Defense	2,195	1,942	1,042	1,045	1,128	924	2,308	2,207	1,770	1,713	8,443	7,831
(2)	381	361	637	666	266	247	222	206	1,659	1,480	3,165	2,960
(1)	4	3	6	5	2	2	2	2	17	15	31	27
NASA (1)	.....	.....	1	1	.....	.....	.....	.....	2	2	3	3
Transportation:												
Coast Guard (2)	1,156	225	.....	.....	16	16	9	9	12	12	1,193	262
	145	145	.....	.....	.....	.....	.....	.....	.....	.....	145	145
FAA (2)	306	310	.....	.....	717	749	801	877	486	505	2,310	2,441
Total	6,102	4,903	3,474	3,505	2,319	2,128	4,274	4,290	5,467	5,252	21,636	20,078

(1) Personnel funded by other agencies.
(2) Man-years.

Table 15--Agency supporting research costs, by function
(Thousands of dollars)

Agency	Observation		Description		Prediction		Dissemination		Systems		Support		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Agriculture	259	291	383	416	301	326	.....	.....	.....	.....	.....	.....	943	1,033
AEC	215	235	171	188	43	47	.....	.....	.....	.....	.....	.....	429	470
Commerce	4,238	4,290	2,789	2,904	2,435	2,549	38	60	1,250	1,215	612	517	11,362	11,535
Defense	5,051	5,572	2,839	3,140	2,945	3,137	1,540	1,563	.....	.....	3,250	4,762	15,625	18,174
EPA	5,780	5,780	2,600	2,600	50	50	.....	.....	.....	.....	.....	.....	8,430	8,430
NASA	32,633	34,723	.....	.....	.....	.....	.....	.....	1,080	1,894	.....	.....	33,713	36,617
Transportation:														
FAA	1,809	1,625	.....	.....	15	20	2,823	3,795	3,226	2,260	.....	.....	7,873	7,700
Total	49,985	52,516	8,782	9,248	5,789	6,129	4,401	5,418	5,556	5,369	3,862	5,279	78,375	83,959

and their motions, cloud-top temperatures, and (with some restrictions) the vertical temperature profile of the atmosphere.

Table 16 shows the number of locations at which each of the Federal agencies make surface and upper air observations, together with the number of aircraft-years devoted to aircraft reconnaissance observations.

SURFACE OBSERVATIONS

Agencies of the Departments of Commerce, Defense, and Transportation, AEC, and NASA together operate about 1,100 locations for surface observations to support basic analysis and forecasting functions and certain specialized services. Besides this cadre of stations, more than 13,000 other stations are

Table 16.--Number of locations by observation function, fiscal years 1974-75

Observation function	Agency	FY 74	FY 75
SURFACE (land)	Commerce[1]	511	536
	Defense	284	274
	Transportation (FAA)	347	359
	NASA	3	3
	AEC	2	2
SURFACE (marine)	Commerce (merchant ships cooperative program)	2,305	2,305
	Transportation (Coast Guard)[2]	287	284
	Defense (ships with meteorological personnel	28	26
	Commerce and Transportation (ocean stations)	4	1
UPPER AIR (rocket)	NASA (U.S.)	1	1
	NASA (overseas)	1	1
	Defense (U.S.)	3	3
	Defense (overseas)	2	2
	AEC (U.S.)[3]	1	1
	AEC (overseas)[3]	2	2
UPPER AIR (balloon)	Commerce (U.S.)	106	106
	Commerce (overseas)	40	40
	Defense (U.S.)	6	6
	Defense (overseas)	11	11
	Defense (ship)	23	22
	Defense (mobile)	19	15
	NASA (U.S.)	3	3
	AEC (U.S.)	2	2
	Commerce and Transportation (ocean stations)[4]	4	1
WEATHER RADAR	Commerce (U.S.)	94	95
	Defense (U.S.)	102	100
	Defense (overseas)	25	21
	Transportation (Coast Guard)[5]/ Commerce	1	1
	NASA (U.S.)	2	2
WEATHER RECONNAISSANCE	Defense (No. of aircraft years)	29	24

[1]Cooperative stations operated by Departments of Agriculture, Interior, and Transportation, other public and private agencies, and those manned by volunteers are not included. Also excluded are 272 Supplementary Aviation Weather Reporting Stations and foreign cooperative stations included in previous plans.

[2]Includes 93/84 ships and 194/200 shore stations supporting marine activities.

[3]No operational funds programmed.

[4]Department of Transportation (Coast Guard) has 22/17 vessels, including 6/5 icebreakers, equipped for upper air observations. These support the high endurance cutter programs and other activities as required.

[5]Ocean Weather Station Hotel.

operated by volunteer private citizens and by employees of the Departments of Agriculture and Interior. The volunteer stations support climatological investigations, and the stations of the Departments of Agriculture and Interior serve the specialized needs of agriculture and forestry.

Surface observations are also made from many ships at sea. The Department of Commerce operates a program of cooperative observations from more than 2,300 vessels of the merchant fleet. The Department of Transportation's Coast Guard operates 84 ships and 200 shore and island stations, as well as 1 ocean weather station which is operated jointly with the Department of Commerce. Ships of the Department of Defense also routinely contribute observations. At nearly all of these marine stations, the ordinary surface weather observations are supplemented by observations of the state of the sea.

As the economic value of a full understanding of the environmental impacts of human activities becomes more obvious, certain observing stations are being designated as *benchmark* stations. There especially detailed observations are made to establish a reliable record for the early detection of secular climatic trends. In some areas the impact of air pollution makes it necessary to plan for an extra-dense network of observing stations to serve the needs of short-range mesoscale forecasting services. Such networks have been operated on an experimental basis by the Department of Commerce near Atlantic City, N.J., and Norman, Okla. (this latter primarily to support the National Severe Storms Laboratory) and by the Department of Defense's Air Force Cambridge Research Laboratory in Bedford, Mass.

UPPER AIR OBSERVATIONS

The upper air observing network provides the data that form the basis for all numerical analysis and forecasting--the fundamental depiction of the dynamics of the earth's atmosphere that underpins all but the most circumscribed local forecasting. The bulk of the network is the nearly 150 stations operated or supported by the Department of Commerce in the U.S. and overseas. The Department of Defense operates a number of fixed and shipboard stations, together with 15 mobile stations that support special Defense projects and also may deploy to support, within assigned mission priorities and capabilities, research and development programs such as the National Hail Research Experiment, the National Severe Storms Laboratory, and the international GATE experiment.

Other upper air stations are operated by NASA and AEC at test ranges and research facilities. These observations can be added to the basic network at times of severe weather alerts as provided by the *National Severe Local Storms Operations Plan* (FCM 73-1, pp. 47-50). The Department of Commerce makes special upper air soundings to 3 kilometers in support of air pollution responsibilities of the Environmental Protection Agency. These soundings are too abbreviated to be of much use in large-scale synoptic analysis and forecasting, but are distributed over the Service C network for use in local forecasting, and especially for severe storm warnings.

NASA, AEC, and the Department of Defense use rocketsondes for obtaining temperature and wind measurements from altitudes above about 30 kilometers. These data support special high-altitude operations and contribute heavily to scientific knowledge of the outer atmosphere.

WEATHER RECONNAISSANCE OPERATIONS

The aircraft reconnaissance program of the Department of Defense provides valuable data from the large areas of the oceans where island and ship observations are scarce. Aircraft reconnaissance is also used to obtain precise information on the location, movement, and physical characteristics of tropical cyclones in the western Atlantic, the Caribbean, the Gulf of Mexico, and the Pacific, as well as of winter storms off the east coast of the U.S. Aircraft reconnaissance is requested only after a thorough evaluation of other data sources (such as satellites, radar, and ground stations) indicates that additional intelligence from an aircraft mission is essential to the protection of U.S. lives and property. Procedures for calling up these reconnaissance flights are detailed in the *National Hurricane Operations Plan* (FCM 73-4) and the *National East Coast Winter Storms Operations Plan* (FCM 73-7).

Special high-altitude flights are conducted by the Air Force to support meteorological research programs, and Naval weather reconnaissance aircraft have the auxilliary capability to make limited oceanographic observations with air-dropped bathythermographs, capable of sounding ocean temperatures to a depth of 300 meters.

Nearly all aircraft reconnaissance is handled by the fleet of 20 WC-130s of the Air Force and 4 WP3As of

the Navy. On some occasions aircraft of NOAA's Research Flight Facility perform reconnaissance in the North Atlantic, Caribbean, and Gulf of Mexico, but these aircraft are normally operated only for support of research programs.

WEATHER RADAR OBSERVATIONS

Radar is a principal source of weather information for making the short-term warnings of severe weather that contribute heavily to saving lives and property in many areas of the Nation. These radar observations provide:

- The best method now available for the remote identification and tracking of squall lines, tornadoes, and other destructive storms.
- A means for locating, tracking, and estimating the intensity of hurricanes as they approach the coast.
- The information upon which estimates of precipitation rates and amounts can be based for use in flash-flood warnings and in managing water resources.
- A means for detecting strong turbulence in convective storms.

Radar observations contribute to the basic meteorological service by measuring the intensity and motion of large areas of precipitation on the synoptic scale. For this use, radar observations must be combined into a reporting network with a central analysis facility. In their role as detector and tracker of small-scale severe weather phenomena, radar observations must be passed rapidly in a communications network dedicated to reaching those who need to take quick action to avert a disaster.

The Federal Plan for Weather Radars (FCM 73-5) identifies the needs for local warning and network

Tornado approaching Athens, Georgia on March 31, 1973. Hook echo approximately 13 WSW of center of the radar scope.

weather radar observations and describes a coordinated long-term plan to meet those needs most economically. The Basic Weather Radar Network, established in the Plan to make detailed observations on a scheduled basis, uses Department of Commerce and certain Department of Defense radars. In the Mountain States air traffic control radars of the Federal Aviation Administration are used to supply limited observations in regions where normal weather radar installation is very expensive and severe weather is infrequent.

Observations from the weather radar network in the conterminous States are collected at the National Meteorological Center, compiled and sent over the facsimile and teletypewriter systems for use in forecasts, warnings, and pilot briefings at civil and military weather service stations.

WEATHER SATELLITE OBSERVATIONS

Satellites play an increasingly important role in providing meteorological data needed for weather analysis and forecasting, for severe weather warning service, and even for oceanography. In addition to cloud images from the entire globe, the weather satellites of the Departments of Commerce and Defense provide temperature profile soundings which partially satisfy common requirements for upper air data over the remote ocean areas. NOAA 3, launched on November 6, 1973, increases the reliability of the orbiting system which provides this important information. The GOES system of geostationary satellites, scheduled to get under way with the launch of SMS A in 1974, will bring into fully operational status the capability of tracking individual cloud elements to derive upper-level winds for analyses and forecasts over otherwise data-sparse regions. The GOES system will also provide near-continuous surveillance of the tropical oceans for the birth of hurricanes and other major storms.

The Defense Meteorological Satellite Program (DMSP) is an operational polar-orbiting system fitted with a high-resolution low-light-level television camera. Formerly called DAPP and DSAP, the DMSP is managed by the Air Force. DMSP data is furnished by the Air Force to NOAA for further dissemination through standard communications channels to the international meteorological community.

Other details of the weather satellite programs are covered in the Weather Satellite section of this Plan.

Program Changes for Fiscal Year 1975

Table 17 lists the total operational costs, by agency, for each type of observation for FY 1974 and FY 1975.

A program reduction occurred during FY 1974 with the withdrawal by the United States of its ocean stations with the exception of Ocean Weather Station Hotel located just off the east coast of the U.S. This change accounts for a reduction of $3,300,000 in annual costs to the Coast Guard and $800,000 to the Department of Commerce.

Commerce, in FY 1975, plans to expand the

Table 17.--Agency operational costs by type of observation
(Thousands of dollars)

Agency	Surface		Upper air (balloon)		Upper air (rocket)		Weather reconnaissance		Weather radar		Weather satellite		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
AEC	301	324	559	603	.....	.....	.....	.....	.....	.....	.....	.....	860	927
Commerce	27,954	27,954	13,362	13,362	.....	.....	.....	.....	7,891	9,391	42,612	39,786	91,819	90,493
Defense	11,632	8,603	5,406	6,310	2,541	2,879	41,443	28,132	3,847	864	22,106	25,618	86,975	72,406
EPA	.....	.....	150	.....	.....	.....	.....	.....	.....	.....	.....	.....	150	.....
NASA	69	70	114	89	44	46	35	19	.....	.....	.....	.....	262	224
Transporation:														
Coast Guard	3,354	1,797	2,236	450	.....	.....	.....	.....	.....	.....	.....	.....	5,590	2,247
FAA	7,072	10,063	.....	.....	.....	.....	.....	.....	3	844	.....	.....	7,075	10,907
Total	50,382	48,811	21,827	20,814	2,585	2,925	41,478	28,151	11,741	11,099	64,718	65,404	192,731	177,104

weather radar coverage of the country by filling a gap in the basic network with a long-range weather radar in south-central New York state at $420,000 and procure 25 local warning radars at $1,080,000. Eight local warning radars also are planned to be installed in continuation of the program begun in FY 1974.

In connection with its satellite activities, Commerce plans to procure a GOES spacecraft at $5,173,000, and begin procurement of ground equipment for the next generation of polar-orbiting satellites at $1,000,000. More details of these programs are included in a separate section, Weather Satellites, of this Plan. Related to this program, Commerce plans to procure photorecorders to display observations from the GOES system for 18 WSFOs and to annualize the operation of 18 other WSFOs previously staffed and equipped with an increase of $621,000.

The Department of Defense experienced a number of changes to their previously reported FY 1974 programs. Additional reductions in FY 1974 in observing manpower due to consolidation and restructuring of observing network centers of $671,000, reductions in upper air stations at overseas locations amounting to $336,000, and reduction in airborne weather reconnaissance force structure and in flying hours amounting to $372,000 are reflected in the Air Force programs. On other programs in FY 1974, the Air Force will expend an additional $1,342,000 for modifications, and data and logistic support requirements for the six self-contained weather radars for the Tactical Weather System previously reported, an additional $234,000 for the GOES Data Utilization Station at its Global Weather Central, and as a new item not formerly included in this Plan, $1,024,000 as the Air Weather Service portion of the program costs of operating the Defense Meteorological Satellite Program (DMSP).

For FY 1975 the Air Force plans further reductions primarily from additional reduction of forces and as a result of completion in 1974 of previously reported programs. Included are $62,000 for force reductions in observing manpower due to consolidation and restructuring of observing work centers and $8,361,000 from a reduction in airborne weather reconnaissance flying hours and reprogramming of weather reconnaissance forces. Further reductions in FY 1975 include the following: $2,496,000 as a result of completing the program to relocate weather sensor readouts and communications equipment from representative observation sites; $4,700,000 in the reconnaissance program as a result of completing the conversion of aircraft to the WC-130H and reduction of purchase of AMT-13 dropsondes; $2,570,000 from completing the procurement of weather radars for the Tactical Weather System; and $608,000 from procurement and installation of GOES data utilization station at the AFGWC. The Air Force plans increases in FY 1975 of $609,000 to purchase and install 34 lightning warning detectors, $438,000 for increased cost of munitions for rocketsondes, and $340,000 to procure 15 rawinsonde mini-computers. The use of the mini-computers will save $73,000 in manpower costs.

The U.S. Navy, in FY 1975, is planning a number of actions in the observing function, both increases and decreases, for a net increase of $1,641,000. Within these actions, the Navy is adjusting its equipment program to obtain an optimum surface observing capability for a net reduction of $475,000, reducing the acquisition of HASP III rocket systems from 325 to 250 for a reduction of $100,000, adjusting procurement of aircraft meteorological equipment for a reduction of $250,000 and $300,000 for deleting procurement of weather radars. The Navy is also taking a number of actions to expand the use of meteorological satellite observations. The most significant of which is the procurement of shipboard satellite readout equipment for $2,800,000.

The FAA, in FY 1974, is procuring and installing additional observation equipment for a number of airfields at an increase of $1,985,000. This program is planned to be continued in FY 1975 at an additional increase of $5,025,000. The equipment includes runway visual ranges, rotating beam ceilometers, hygrothermometers and wind. In addition, the FAA is planning to procure and install remote weather radar displays at a number of airfields for $844,000. These actions, plus numerous other smaller planned activities including the implementation of observing services at 19 new tower locations provide a net overall increase in FY 1975 of $3,822,000.

ANALYSES AND FORECASTS

Description

There are four major types of analysis and forecast centers and offices: primary, area and guidance, local, and specialized. Primary centers produce basic analyses and forecasts and provide basic warning services. Area and guidance centers and offices supplement the products of primary centers and adapt them to their

particular regions. Local offices issue short period warnings to the general public. Specialized centers serve the unique requirements of specific user groups or provide a service not available from other centers, such as fire-weather support.

PRIMARY CENTERS

The Department of Commerce operates four primary centers. The NOAA National Meteorological Center (NMC) at Suitland provides basic weather analyses and forecasts for the Northern Hemisphere and for portions of the Southern Hemisphere. During a typical day NMC processes more than 40,000 surface observations, 2,000 ship reports, 1,500 upper air soundings, several hundred vertical soundings derived from satellite data, 2,800 aircraft reports, and global cloud-cover data from weather satellites. Products of NMC include more than 400 charts for facsimile transmission and 200 messages for teletypewriter distribution daily to its users primarily in North America but also in overseas areas.

The Department's responsibility for establishing and operating a national operational environmental satellite system is fulfilled by the NOAA National Environmental Satellite Service (NESS) at Suitland. NESS also processes data from both operational and research and development meteorological satellites to provide outputs required by civil and military users. Satellites have made significant contributions to forecasts and warnings of hurricanes and other major severe storms by providing information on their existence and intensity in areas of few or no conventional observations. NMC, NESS, and the National Climatic Center at Asheville collectively form a World Meteorological Center with global responsibilities for analyses and forecasts and for collection and retrieval of data under the international World Weather Watch program.

The NOAA National Hurricane Center (NHC) and the Regional Center for Tropical Meteorology (RCTM) are operated by Commerce and collocated in Miami. NHC provides basic forecasts and warnings of hurricanes in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico for all Federal agencies and user groups. RCTM, designated by the World Meteorological Organization as part of the World Weather Watch, produces basic analysis and forecast information for the tropical latitudes, supplementing the mid- and high-latitude products of NMC. Major objectives of NHC are to improve timeliness and accuracy of the hurricane warning program by developing automated data handling, display, and processing capabilities to accommodate the data from satellites and aircraft reconnaissance; reduce the average position error in the 24-hour hurricane forecast; and advance the warning time for hurricanes approaching coastal areas.

A better understanding of the dynamics of hurricanes and of the basic environmental parameters necessary for hurricane prediction is needed, as are prediction models and techniques and adequate data on hurricane location, movement, and intensity. The National Hurricane Research Laboratory at Miami, Fla., is conducting fundamental research in this area. Also, an operational numerical hurricane prediction model is being developed by NMC.

The NOAA National Severe Storms Forecast Center (NSSFC) at Kansas City, Mo., is the source for severe thunderstorm and tornado watches in the United States in support of civil needs. The Center is responsible for the preparation and distribution of watches that designate areas where the likelihood of severe thunderstorms or tornadoes is high.

Major objectives of NSSFC are to improve the tornado and severe thunderstorm watches by reducing the size of the watch area (average 27,000 square miles), increasing the lead time of watches, being more specific as to time and place of occurrence, and developing computer data handling, display, and processing techniques. Although methods used in forecasting and warning of tornadoes and severe thunderstorms have vastly improved in the past 20 years, needs for better detection and forecasting techniques continue to be critical. Far too many people are unnecessarily alerted by the overly large tornado watch areas, 41 percent of which verify with one or more tornadoes. Furthermore, only about 30 percent of the reported tornadoes are in valid watch areas. Improved forecast, detection, and warning techniques can only follow continued investigation and more knowledge of this small, violent storm.

The Department of Defense operates two primary centers. The Air Force Global Weather Central (AFGWC) at Offutt AFB provides basic analysis and forecast products in support of worldwide Defense aerospace and ground operations. Products from AFGWC are distributed to globally dispersed Defense facilities and forces by facsimile, teletypewriter, and high-speed communications systems. The European Tactical Forecast Unit at Kindsbach, Germany, and

the Asian Tactical Forecast Unit at Fuchu Air Station, Japan, formerly primary centers, had their functions absorbed in large part by AFGWC, and are now considered area and guidance centers. The AFGWC provides tailored severe weather warnings to approximately 600 Defense and Defense-contracted installations and facilities. Severe weather warnings are transmitted in a narrative and graphical form. They depict areas within the conterminous United States having the potential to produce weather phenomena which can be hazardous to aircraft and ground operations. In addition, point warnings are provided for a large number of military locations. These warnings, which go directly to the affected installations by means of defense communications system teletypewriter circuits, define the type, intensity, and duration of the expected hazardous weather. The second DOD primary center, the Navy Fleet Numerical Weather Central (FNWC) at Monterey, provides analysis and forecast products in support of naval requirements. Products from FNWC are disseminated over the Naval Environmental Data Network (NEDN) to Fleet Weather Centrals, Facilities and Naval Weather Service Environmental Detachments (NWSED) located throughout the world, and to naval ships through interlinking fleet facsimile and teletypewriter broadcasts. Exchanges of products among Defense processing centers are made via computer-to-computer high-speed data links.

The threat of power shortages and failures along the eastern seaboard jeopardizes the capability of NMC to provide basic weather analyses and forecasts. A cooperative arrangement, outlined in the *Federal Plan for Backup Among Operational Processing Centers*, exists to provide continuous service in such a contingency. Should NMC fail because of a power or computer failure, AFGWC will provide selected essential meteorological charts for entry on the National Facsimile Network (NAFAX) at Kansas City. Arrangements have also been made for AFGWC to provide NMC's aviation winds forecasts and NSSFC's severe local storms forecast if those centers are out of operation for an extended period. The arrangements are detailed in the *Federal Plans for Cooperative Backup for Severe Local Storms and Aviation Winds Forecasts.*

AREA AND GUIDANCE CENTERS

Area and guidance centers form the intermediate level in the weather analysis and forecasting structure. These centers, using the products of primary centers, are responsible for forecasts and warnings within their assigned areas. They also provide detailed guidance and support to civil or military weather service offices within their areas.

The Department of Commerce operates 54 area and guidance centers--50 Weather Service Forecast Offices (WSFO) and 4 Regional Weather Coordination Centers (RWCC). Each WSFO provides forecasts and warnings for one or more States or for large portions of one State. Forecasts are issued twice daily for periods up to 48 hours. Area or statewide warnings are issued to the public in critical weather situations. These forecast centers also provide the main field forecast support for all specialized forecast services such as marine, aviation, agriculture, and fire weather.

In addition to their primary forecast function, several WSFOs, Boston, Mass., Washington, D.C., New Orleans, La., and San Juan, P.R., after coordination with NHC, are responsible for hurricane warnings in their respective areas of responsibility. In accord with international agreements, the Eastern Pacific Hurricane Center at WSFO San Francisco, Calif., and the Central Pacific Hurricane Center at WSFO Honolulu, Hawaii, provide forecast and warning services for the eastern and central Pacific Ocean similar to those of NHC for the Atlantic, Caribbean Sea, and Gulf of Mexico. Hurricane advisories and bulletins prepared by the Warning Offices for the general public and marine interests contain the position, intensity, direction and rate of movement, and other significant characteristics of the storm.

The Department of Commerce's Regional Warning Coordination Centers are responsible for coordination of warnings that involve two or more states, for monitoring the forecast products to insure consistency, for control of the quality of forecast products and for arbitrating when conflicts arise concerning forecast and warning issuance. As an example of the RWCC mission, the RWCC in New York City, in cooperation with several Federal agencies, keeps a special, intensive watch on a 150-mile-wide strip of the Atlantic along the east coast to detect and track storms approaching the densely populated coastal region from offshore.

The Department of Defense operates three area and guidance centers in the United States and six in overseas areas to meet its global military requirements. These centers are uniquely oriented to support military operations.

Local Offices

The DOC Weather Service Offices (WSO) provide a link with the public and the specialized user. Local forecasts issued by these offices are adaptations of the zone forecasts issued by the WSFOs. They are issued to meet local service requirements. The WSOs have responsibility for monitoring and issuing severe weather warnings in their area of responsibility.

The DOD's local weather offices at military bases provide meteorological support tailored to meet the mission needs of local military units.

SPECIALIZED CENTERS

Specialized centers meet the unique requirements of a specific user group. With funding support from NASA, Commerce provides small but highly specialized centers to support the space program. The NOAA National Climatic Center (NCC) at Asheville, jointly operated and funded with Defense, is the central archival, processing, and service center for weather records collected by all Federal agencies.

Defense operates two specialized centers: The USAF Environmental Technical Applications Center (USAF ETAC), Washington, D.C., and its subunit at Asheville, N.C.; and the Joint Typhoon Warning Center, Guam. USAF ETAC conducts climatological studies for operational planning, quality control of data taken by DOD units and archiving of specialized military observations. The Joint Typhoon Warning Center on Guam prepares typhoon warnings for the North Pacific west of longitude 180°.

Program Changes for Fiscal Year 1975

Table 18 lists the total operational costs, by agency, for the three types of centers for FY 1974 and FY 1975.

The significant changes are by the Department of Defense and are primarily concerned with increased automation and realignment of functions. Federal pay raises also impact the increases indicated. In FY 1974, the USAF provided for further centralization at AFGWC of terminal forecasts, computer flight planning, and the production of basic products for its European and Asian units at an additional $695,000, and enhanced the capabilities of the computers at AFGWC at $192,000. The USAF had reported plans to increase the capabilities at ETAC to use the ARPA net at an increase of $486,000 in FY 1974. A change in plans deleted this item and in its place the USAF developed an in-house capability at ETAC with the purchase and lease of processing equipments at an increase of $548,000. The increase of $1,452,000 for area and guidance centers stems primarily from a redefinition of the European and Asian centers from primary to this category.

In FY 1975, the USAF plans to purchase rather than lease an advanced computer at AFGWC at $1,400,000, upgrade an additional computer plus enhance the capabilities of existing equipment and add a mini-computer to its message handling activities at an increase of $1,088,000, and provide additional space for the computers and ADP equipment at $600,000. The USAF also plans to continue the acquisition of its mini-computer based interactive processing and display system at an additional $400,000. A reduction in personnel at the overseas area and guidance centers accounts for a reduction of $307,000, and the completion of acquisition of computers for USAF ETAC in FY 1974 plus a

Table 18.--Agency operational costs by type of center
(Thousands of dollars)

Agency	Primary		Area and guidance		Specialized		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	23,030	23,030	9,417	9,417	22,695	22,695	55,142	55,142
Defense	15,295	21,231	7,975	7,675	4,988	4,453	28,258	33,359
EPA	.....	.....	.....	.....	150	.....	150	.....
NASA	.....	.....	.....	.....	587	524	587	524
FAA	.....	.....	.....	.....	149	157	149	157
Total	38,325	44,261	17,392	17,092	28,569	27,829	84,286	89,182

reduction in personnel accounts for an additional reduction of $375,000.

The U.S. Navy, in FY 1975, plans to purchase ADP equipment for processing weather satellite data at the Central Processing Facility collocated with the Fleet Numerical Weather Central (FNWC) at Monterey for $2,400,000. Increased operational costs at FNWC account for an increase of $148,000 and reduced services from NOAA at the National Climatic Center accounts for a reduction of $160,000.

COMMUNICATIONS

Description

The communications function supports the environmental prediction and warning service by collecting and distributing environmental data to Federal, State, and local agencies for use in forecasts and warnings and for the general public.

Because the weather is changing constantly, rapid communications facilities for meteorological operations are essential to the timely collection of weather data for centralized processing and for direct application by many user groups. Weather communications facilities are also used to distribute processed information from processing centers and civil and military weather service offices to the public and to various specialized users. Demands for improved service created by the increasing range and speed of modern aircraft require the timely collection and exchange of observations from most areas of the world for operational uses and for inputs to the analysis and forecasting routines at weather centers.

For more than 40 years, teletypewriter systems have been a means for collecting and distributing observations and forecasts. Facsimile systems are now widely used to distribute weather maps and other graphical products from weather centers. Demands for increased amounts of data, greater collection speed, and more products from computers in weather centers have led Federal agencies to increase their use of high-speed digital systems as replacements for some teletypewriter and facsimile networks. Data are generally transferred at high speed by computer-to-computer links.

To make government communications more effective and to promote coordinated communications systems planning, the Office of Telecommunications Policy (OTP) set forth the "Lead Agency" policy with its Circular No. 12, October 12, 1973. The Department of Commerce was designated the lead agency in environmental communications. The major meteorological communications systems in use are:

TELETYPEWRITER AND HIGH-SPEED SYSTEMS

The teletypewriter and high speed communications systems provide the needed collection and distribution of alphanumeric weather data and information with agency functions as follows:

- The Federal Aviation Administration handles the basic national teletype system which collects and distributes weather observations and forecasts used in common by the other agencies.
- The Department of Commerce provides its internal communication systems and is also responsible for certain international circuits required as part of its commitment as a World Meteorological Center.
- The Department of Defense supports and maintains those systems unique to military requirements.

Federal Aviation Administration

The Modernized Weather Teletypewriter Communications System (MWTCS) consolidates the circuit control and relay functions of Services A, C, and O into a single Weather Message Switching Center (WMSC) at Kansas City. These functions are performed automatically by a group of electronic computers combined to operate as a real-time store and forward communications switch. All Service A and C circuits extend directly into the WMSC. Certain Service O circuits also extend directly into the computer switch, while others, from overseas points, pass through the Aeronautical Fixed Telecommunications Network switch which is collocated and interconnected with WMSC. Computer-to-computer links provide for the exchange of data between WMSC and the National Meteorological Center (NMC) at Suitland and between WMSC and the Air Force Automated Weather Network (AWN) at Carswell AFB, Tex.

Circuits of MWTCS are classified and described as follows:

- *Service A Area Circuits:* Forty 100-wpm (words per minute) multipoint half-duplex circuits designed solely to meet the collection and routine distribution requirements of the average FAA and National Weather Service (NWS) user. Other users may obtain receive-only drops on these circuits if their needs are compatible with those of FAA and NWS.

- *Service A Request/Reply Circuits:* Forty 100-wpm half-duplex circuits which parallel the Service A Area Circuits and enable Government flight briefing facilities to obtain information not routinely transmitted to the associated Area Circuit.
- *Service A Low-Speed Nongovernmental Circuits:* Sixteen 100-wpm multipoint circuits for distributing data to meet the requirements of nongovernment users, principally airlines whose needs are not satisfied by the Area Circuits.
- *Service C Area Circuits:* Six 100-wpm multipoint half-duplex circuits for collecting and distributing Service C data to serve both government and nongovernment users.
- *Service O Area Circuits:* 67- and 100-wpm multipoint half-duplex circuits for collecting and distributing Service O data to both government and nongovernment users.
- *Air Force Circuits:* Twenty-one 100-wpm multipoint circuits for distributing Service A, C, and O data to high-volume AFBs in the United States whose needs cannot be met by Area Circuits alone.
- *Weather Service Forecast Office Point-to-Point Circuits:* Forty-seven 100-wpm full-duplex circuits to the Weather Service Forecast Offices (WSFO) for transmission of forecast products to WMSC and receipt by WSFOs of supplementary weather data.
- *Radio Broadcast Circuits:* 60- and 100-wpm distribution-only circuits for transmitting data on the World Meteorological Organization and Caribbean Meteorological (CARMET) broadcasts.
- *Nongovernment Medium-Speed Circuits:* 1,200-bps multipoint receive-only circuits for ddistributing Service A, C, and O data to very-high-volume airline and other nongovernment users whose needs cannot be satisfied by Low-Speed Circuits.
- *High- and Medium-Speed Links:*

  2,400-bps full-duplex computer-to-computer circuit for exchanging Service A, C, and O data between WMSC and NMC.

  1,200-bps full-computer-to-computer circuit for exchanging Service A, C, and O data between WMSC and the Air Force Air Weather Service.

  1,200-bps full-duplex Notice to Airmen (NOTAM) circuit between WMSC and National Flight Data Center.

Department of Commerce

Radar Report and Warning Coordination (RAWARC) Teletypewriter Network.–The land-line teletypewriter network used to collect and to distribute radar reports and storm warning information is RAWARC. The network is composed of five circuits terminating at the Radar Analysis and Development Unit (RADU) in Kansas City. RADU has drops on all the circuits which terminate at the Automated Relay Center in the Communications Operating Branch, Suitland, Md. Traffic on RAWARC is basically unscheduled and is handled according to a priority system. The only regularly scheduled operation on RAWARC is an hourly collection of radar reports (SD) which are relayed by Suitland as required.

Special Communications Links Between Guidance Centers.–A high-speed numeric and graphic computer link was established in FY 1971 between the National Meteorological Center/National Environmental Satellite Service (NMC/NESS) of NOAA and NHC to improve the exchange of aircraft reconnaissance data, satellite data, and processed information. A similar link has been established between NMC/NESS and NSSFC.

International Circuits.--In addition to the Service O circuits (which FAA funds), the Department of Commerce has nine international circuits to exchange meteorological data among the United States and Canada, U.S.S.R., Cuba, Great Britain, Japan, Mexico, Brazil, the Central American Republics, and Argentina. These include a Washington-Toronto high-speed circuit, a Washington-Moscow circuit for exchange of satellite information, a Washington-Central American loop, a Washington-Buenos Aires low-speed circuit, and three other circuits--Washington-Bracknell (England), Washington-Tokyo, and Washington-Brasilia--that are part of the World Weather Watch main trunk circuit. The Washington-Bracknell circuit is also used to exchange facsimile charts.

Radio Circuits.--Weather messages and observations prepared aboard ships at sea are transmitted by radio, primarily by means of international Morse code, to shore-based radio stations. These messages are relayed to NMC. The Teletypewriter Exchange Service (TWX), international communications carrier facilities, and Coast Guard circuits are used for the relays. Observations are automatically separated geographically and consolidated into bulletins which are distributed on domestic and international meteoro-

logical communications facilities. More than 1,000 observations are processed daily.

Department of Defense

Automated Weather Network (AWN).--AWN, operated and maintained by the Air Force, is the backbone of the military weather communications system. It consists of four real-time communications switching computers at Carswell AFB, Tex., RAF Croughton, England, Fuchu Air Station, Japan, and Clark Air Base, Philippine Islands, linked by high-speed data circuits. The overseas Automatic Digital Weather Switches (ADWS) collect data from radio intercept sites and low-speed feeder circuits. These data are transmitted at 3,000 wpm to the Continental United States (CONUS) ADWS at Carswell AFB where the information is examined, sorted, edited, compiled into specific weather messages, and switched to military and civil customers. Besides low-speed distribution to Department of Defense weather units, data are transmitted by high-speed circuits to the Air Force Global Weather Central (AFGWC), Fleet Numerical Weather Central (FNWC), NMC, and WMSC at Kansas City. All circuits are full duplex, permitting a total exchange of data: reports from field units to military and civil processing centers and products from these centers to the field units.

CONUS Meteorological (COMET) Teletypewriter System.--The primary communications system for collecting, editing, and disseminating environmental data at military stations in the United States is COMET, consisting of three teletypewriter networks--COMET I, COMET II, and COMET III. Each of these teletypewriter networks is subdivided into eight geographical areas. The COMET I network consists of half-duplex 100-wpm loop circuits used for collecting and disseminating airways data. The COMET II network consists of two half duplex 100-wpm loop circuits. One circuit (COMET IIA) is used for collecting data, whereas the other (COMET IIB) is used for disseminating operational weather products and data. The COMET III network consists of half duplex 300-wpm broadcast circuits used for disseminating synoptic and customer tailored data. Polling for data collection on COMET I and COMET IIA and disseminating data over COMET IIB and COMET III are controlled by the 1108 computer at the Carswell ADWS.

Naval Environmental Data Network (NEDN).--NEDN provides for the dissemination of meteorological and oceanographic computer products from FNWC at Monterey to specially equipped locations in the United States and overseas. The Network rapidly collects, processes, disseminates, and displays environmental data and consists of on-line telecommunications equipment, automated display devices, digital computers, and associated circuitry.

FACSIMILE

Facsimile networks and broadcasts are designed to transmit predominantly graphic weather information from selected centers to civil and/or military weather offices and users. The Deparmtent of Commerce is responsible for the basic facsimile circuits, including those which fulfill international commitments. The Department of Defense has responsibility for those circuits filling unique military requirements.

Department of Commerce

The various internal and external networks listed below were established to serve different users and different geographical areas, and include both long-line and radio systems.

National Facsimile (NAFAX) Network.--NAFAX is a long-line network generally used to distribute a comprehensive set of charts depicting analysis, forecast, and selected observational data to civil and military weather service offices and to a variety of other users. Basically a graphics network, NAFAX serves approximately 250 NWS offices, 400 military and civil governmental offices, and nearly 350 non-governmental users--more than 1,000 drops in all.

With the exception of the radar summary charts from RADU and the digitized mosaics from the National Environmental Satellite Service (NESS), all materials originate at NMC. The Network extends throughout the United States, with extensions into Canada at Vancouver and Montreal. Charts are relayed to Alaska over military channels from West Sweetgrass, Mont. In Alaska, selected charts are put on the Intra-Alaska Facsimile Network circuit. Selected charts are also relayed to Honolulu.

National Aviation Meteorological (NAMFAX) Network.--NAMFAX is a long-line network designed to provide selected civil and military weather offices with graphic guidance materials in support of international high-altitude aviation operations. The network operates at 120 and 240 scans per minute with automatic selection of speed and mode. Satellite products are transmitted at a different speed and mode than are weather charts for which signal

compression techniques are employed. The network extends to the Mexican border, and when completed will carry its products to Canada, Alaska, and Puerto Rico.

Forecast Office Facsimile (FOFAX) System.--FOFAX is a long-line network designed to distribute forecast guidance materials prepared by NMC and satellite products from NESS to the WSFOs. It is also used to distribute NESS-prepared digital mosaics obtained from satellite pictures and automatic picture transmission data acquired by NESS Wallops Island, and the WSFO San Francisco. FOFAX operates at two speeds (120 or 240 scans per minute) and has automatic selection of speed and mode.

Tropical Regional Analysis Facsimile Circuit (TROPRAN).--TROPRAN is a long-line network used to distribute tropical area analyses and prognoses. It carries NMC products for use by the National Hurricane Center and provides NESS tropical-area satellite data for all users on the Circuit.

Intra-Alaska Facsimile Network.--This Network is a system of microwave, troposcatter, cable, and high-frequency radio facilities used to distribute graphic materials throughout Alaska. Besides the charts prepared by WSFO Anchorage, selected charts are switched automatically into the Network from NAFAX and AMFAX. At present the Intra-Alaska Facsimile Network serves 10 NWS, 1 Coast Guard, and 13 Defense offices. FAA and NOAA provide funds for that portion of the AMFAX circuit from the international border-crossing point at Blaine, Wash., to Smugglers Cove, Alaska. NWS of NOAA provides approximately 90 percent of the funds for circuitry within Alaska, and the Department of Defense funds the remainder.

Other Facsimile Broadcasts

International radio facsimile meteorological broadcasts are transmitted via leased commercial HF radio transmitter facilities. These broadcasts are beamed primarily toward the Caribbean, Central America, South America, and southwest Pacific areas.

Marine HF radio facsimile meteorological broadcasts are transmitted from the east and west coasts of the United States via Coast Guard transmitter facilities and are intended primarily for reception by ships at sea.

Real-time reconstructed radar images consisting of weather echoes with added handwritten annotations and geographical overlay are transmitted in facsimile mode from WSR-57 radar sites equipped with WBRR transmitters. There are approximately 34 transmitter sites presently equipped with this capability. The two operational modes being employed are hard wire private line circuits leased from common carriers and direct-distance dialing (DDD) via the telephone companies. Either of these services are available to all interested users, government, and non-government.

Department of Defense

Strategic Facsimile Network.--The Strategic Facsimile Network is a landline and microwave net that extends to selected Defense users at approximately 70 locations in the United States. AFGWC at Offutt AFB serves as the transmitting facility. The Strategic Facsimile Network supplements the facsimile systems of the Department of Commerce by providing specialized graphic data oriented to military operations. It is used primarily to support the readiness of U.S. strategic weapons forces and secondarily to support airlift and tactical forces. The Network operates at 120 scans per minute (spm) and uses RJ-4-type facsimile recorders. Most products are computer generated and introduced into the system through digital-to-analog converters.

Overseas Facsimile Networks.--In order to satisfy the needs of military customers overseas, AFGWC at Offutt AFB transmits specialized products to locations in Europe over the European Facsimile Network (EURFAX) and to the Pacific over the Pacific Facsimile Network (PACFAX). Both networks operate at 120 spm and utilize RJ-4 and D-649 recorders. Most products are generated by AFGWC; however, a limited number of specialized, manually prepared products are injected into EURFAX by the European Tactical Forecast Unit at Kindsbach, Germany, and into PACFAX by the Asian Tactical Forecast Unit at Fuchu Air Station, Japan.

Fleet Weather Broadcasts.--The Naval Communications System supports the Naval Weather Service in its requirements for specialized operational communications. Meteorological traffic is handled in the same manner as other Navy traffic; no center or unit is dedicated exclusively to meteorological communications. Meteorological information is transmitted to operating forces of the Navy by means of radio (continuous wave, teletypewriter, and facsimile) broadcasts. Designated Fleet Weather Centrals are responsible for these broadcasts which include observations, analyses, forecasts, and warnings. In preparing broadcasts, the Centrals and Facilities make use of not only their own specialized products and

those from FNWC but also--to the extent possible--products from the Basic Meteorological Service and data from AWN.

Program Changes for Fiscal Year 1975

Table 19 lists the total costs, by agency, of the various types of communications for FY 1974 and FY 1975.

The planned reduction in personnel by the USAF in FY 1974 has slipped a year and this along with Federal pay raises shows an increase over that previously reported of $1,511,000. The FY 1975 reduction in personnel accounts for a decrease of $1,626,000. Other changes in FY 1975 by the USAF include upgrading the computer at the Croughton Automated Digital Weather Switch (ADWS) at an increase of $981,000, upgrading the computer at Carswell ADWS at an increase of $460,000, automating the weather relay operations at Torrejon and Incirlik for $108,000, and installing power supply modules at Clark, Fuchu, and Carswell ADWSs to provide more reliable power systems for $500,000. The U.S. Navy plans to procure a number of radio receivers and supporting equipment for its fleet marine forces for $115,000

The programs planned by the FAA result in relatively minor net changes in their proposed budget. Of significance, within the many relatively small programs, are the plans to phase out the digital switching system (ADIS) for a reduction of $403,000, and to provide new high speed teletypewriters for the Modernized Weather Teletypewriter Communications System at $1,246,000, both in FY 1974. In FY 1975, the major changes are primarily associated with realigning Services A and C at $173,000, and providing or relocating teletypewriters at airport stations at $1,133,000.

DISSEMINATION

Description

Effective dissemination is a vital part of the forecast and warning system. It is the final link in getting the information to the user. For maximum use, warnings must reach all affected members of the public and responsible officials with minimum delay and must convey maximum understanding. This is necessary to allow adequate lead time for making decisions and for taking protective actions to mitigate the effects of weather events. While warnings are needed as rapidly as possible, the dissemination of routine weather forecasts does not have this urgent time requirement. This time requirement varies from a very few minutes in the case of a tornado warning to several days for widespread snowmelt-type flood warnings. In order to serve the large variety of users and effectively meet the wide range of time requirements for product and warning delivery, a mix of dissemination methods is used.

Radio, television, telephone, teletypewriter systems, and newspapers are all used to varying

Table 19.--Agency operational costs, by type of communications
(Thousands of dollars)

Agency	Teletypewriter and high-speed systems		Facsimile		Other		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
AEC	9	9	9	10	.....	.....	18	19
Commerce	5,529	5,529	2,977	2,977	.....	.....	8,506	8,506
Defense	12,999	13,333	6,447	6,539	664	780	20,110	20,652
NASA	23	23	20	20	25	27	68	70
Transportation:								
Coast Guard	125	125	84	83	.....	.....	209	208
FAA	16,921	17,236	730	839	.....	.....	17,651	18,075
Total	35,606	36,255	10,267	10,468	689	807	46,562	47,530

degrees for disseminating environmental forecasts and warnings. They are all designed to serve multi-mission roles. Each routinely provides general weather information, warnings, and forecasts to the public and special user groups.

Although the dissemination system functions satisfactorily in routine situations, it often is inadequate during periods of severe weather. The "Report to the Congress on Disaster Preparedness" by the Office of Emergency Preparedness, January 1972, and the report "The Agnes Floods," by the National Committee on Oceans and Atmosphere, November 1972, and other disaster surveys have pointed to deficiencies in the dissemination system. Improvements are being made in this system, many of which will be discussed in subsequent sections. The AFOS program, discussed earlier, promises to improve the dissemination of forecasts and warnings internally to the meteorological services and more importantly to the public and specialized users.

WEATHER SERVICE OFFICES

NOAA has approximately 250 Weather Service Forecast Offices (WSFO) and WSOs that provide forecasts and warnings to the general public and to responsible State and local officials. Hurricane and tornado warnings are distributed immediately by all available means of communication, but with heavy reliance upon radio and television broadcasting. NOAA weather offices throughout the country make basic dissemination of hurricane and tornado warnings, with key dissemination nerve centers at NHC and NSSFC. Also, many of these WSFOs and WSOs have been supplemented with specially trained personnel who provide weather information for agriculture, fire weather, and other specialized user groups. A few WSOs are operated solely to provide weather information for specialized users, as necessitated by technical or economic considerations. Additionally, DOC has initiated a program with the objective of informing the public of disaster potential through close cooperation with State and local offices in communities where destructive forces of nature are likely.

The Department of Defense operates 278 weather service offices on land and aboard ship that provide forecasting, briefing, climatological, and consultant services in support of military weapons systems, facilities, and installations. Defense mobile units provide weather support for maneuvers, exercises, and special military and contingency operations.

FLIGHT SERVICE STATIONS

The FAA network of 320 FSSs provides weather information to aviation interests at civil airports. Many of these FSS facilities also provide weather-briefing services by telephone to pilots at smaller airports that have no other weather information source. Some airports have both an FAA-FSS and a NOAA-WSO; the FSS personnel handle routine briefings, and the WSFO or WSO takes requests requiring more detailed meteorological information.

MESSAGE TRANSMITTING SYSTEMS

Voice communications methods have a major role in meteorological services. Weather information is disseminated to the general public through telephones, telephone answering recorders, VHF/FM, and other radio broadcasts. Use of recorders for distributing weather information to the public, marine, and other specialized groups is on the increase; recorders allow a growing number of users to be served at minimum expense. For aviation users FAA broadcasts recorded weather observations, and the National Weather Service of NOAA provides forecasts and warnings.

NOAA operates a continuous radio weather broadcast service consisting of 66 VHF/FM radio stations. This broadcast, transmitted on frequencies 162.40 MHz and 162.55 MHz, provides continuous weather forecasts and warnings and other pertinent weather information directly from weather offices to the local community consisting of the general public, mariners, safety officials, news media, utility companies, schools, and anyone else having need for up-to-the-minute information. Through a tone-alert device, specially equipped radio receivers can be demuted by the NOAA transmitter, thus giving an immediate alert to anyone having this special receiver. This alert would be followed by the warning information.

The Coast Guard operates a number of radio stations to disseminate forecasts and warnings for coastal and offshore areas. The FM radio systems are also being used as emergency communications to link essential Commerce facilities with news media and public agencies in areas where hurricanes and severe storms frequently disrupt normal communications. The Department of Defense operates 101 two-way radio facilities in the United States for direct voice contacts between weather personnel and airborne pilots.

The NOAA Weather Wire Service (NWWS) is a system of statewide and areawide teletypewriter

circuits used to distribute consumer-oriented weather warnings, forecasts, and data from Weather Service Forecast Offices (WSFO) to the news media for relay to the public and various specialized users. It provides on an optional basis visual and audio capability to alert all users to critical incoming messages. WSFOs and WSOs have direct entry on these circuits. The WSFOs furnish broadscale information, and the WSOs enter local information. The Service also includes three 100-wpm teletypewriter overlay-relay circuits which enable State Relay Centers to obtain and further distribute the required information from other States. The NWWS is expanding in FY 1975 to cover all but three of the conterminous States. Plans call for eventual expansion nationwide to service approximately 5,000 radio stations, 600 television stations, and 1,700 newspapers in 3,000 cities and towns. The mass media subscriber pays only for the use of a local line and equipment.

Telescriber systems are used at many civil and military airfields to disseminate observations, forecasts, and warnings to air traffic controllers, aircraft operations offices, and other users. Closed-circuit television is used extensively by Defense to distribute weather information and to brief pilots and operational control personnel on the weather.

There are over 60 cable television systems that automatically receive their local forecast from NWWS and continuously display this information on a special channel. Forecasts and warnings are automatically changed upon receipt via NWWS.

NWS is experimenting with an audio-visual weather service program over a channel of the Great Falls, Mont., CATV system. All information originates at the Weather Service Forecast Office and is sent to the cable office via coaxial cable for distribution to the CATV customers.

The Department of Commerce, Coast Guard, State and local governments, and private interests cooperate in a Coastal Warning System to warn pleasure boatmen and other marine interests that lack radio receiving equipment of impending weather conditions on coastal and inland waters. More than 450 flag or light displays are operated along the seacoasts, the shores of the Great Lakes, and on the inland waterways.

Program Changes for Fiscal Year 1975

Table 20 lists the total operational costs, by agency, for each of the dissemination categories.

The Department of Commerce, in FY 1975, will significantly improve its capability to disseminate weather forecasts and warnings by completing or extending the NOAA Weather Wire Service in 10 states at $1,221,000. In its related continuing program to improve community preparedness, Commerce will add 11 community preparedness specialists, nine of which will be at various WSFOs throughout the country at $330,000.

A new thrust being initiated by Commerce in FY 1975 is the Automation of Field Operations and

Table 20.--Agency operational costs, by type of dissemination to users
(Thousands of dollars)

Agency	Weather Service Offices		Flight Service Stations		Message Transmitting Systems		Studies and Consultants		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
AEC	123	133	.....	.....	.....	.....	.....	.....	123	133
Commerce	17,369	20,840	.....	.....	4,503	5,724	.....	.....	21,872	26,564
EPA	.....	.....	.....	.....	.....	.....	100	.....	100	.....
Defense	26,795	26,395	600	600	502	503	3,853	4,336	31,750	31,834
NASA	.....	.....	.....	.....	68	74	8	8	76	82
Transportation:										
Coast Guard	.....	.....	.....	.....	202	210	400	.....	602	210
FAA	.....	.....	6,409	7,008	9,319	11,248	.....	.....	15,728	18,256
Total	44,287	47,368	7,009	7,608	14,594	17,759	4,361	4,344	70,251	77,079

Services (AFOS) program. The development of AFOS has reached the operational stage and during this budget year it is planned to purchase storage, display, and communications devices built around minicomputers for six WSFOs, six WSOs, one River Forecast Center, and to equip the National Meteorological Center (NMC) and a system monitoring and coordination center. The FY 1975 budget for AFOS amounts to $3,471,000 which includes $371,000 to provide NMC with the ability to support implementation of the system.

Among the readjustments for its FY 1974 programs, the FAA plans to procure equipment for recording and continuous broadcast of weather information at an increase of $1,196,000, and to procure additional equipment to provide improved in-flight weather information service to pilots at an increase of $1,292,000. This program is being continued in FY 1975 with a planned increase of $1,856,000. The FAA's En Route Flight Advisory Service (EWAS) was implemented in 1972 at four Flight Service Stations on the West Coast with 12 air/ground outlets in support of this service. It is planned to expand this program in FY 1975 with 19 additional locations with associated radio and weather equipment at a total increase of $2,664,000.

The USAF experienced reductions in services and base closures in FY 1974 and plans similar reductions in FY 1975 for decreases amounting to $352,000 and $1,076,000 for each year respectively. Increases in personnel providing consulting services and weather liaison functions to other Federal agencies account for an increase of $750,000 in FY 1974, and an additional $472,000 in FY 1975. Also in FY 1975, the USAF plans to modernize the base weather station communications within the conterminous States with the replacement of all teletypewriter equipment with high speed printers and visual display terminals at $625,000. The U.S. Navy plans some consolidations and realignment of functions primarily as a result of deactivation of a number of detachments with little impact on its budget.

GENERAL AGENCY SUPPORT

Description

General agency support covers four activities–internal support, training, maintenance, and management above operating level--which agencies must sustain to operate effective meteorological service programs.

INTERNAL SUPPORT

General mission-related activities in support of meteorological operations within an agency are necessary for providing service to users. These activities include the following types of programs:

- Engineering support for planning, preparing technical specifications, surveying equipment sites for suitability, accepting and installing new equipment, and calibrating, maintaining, and repairing commissioned equipment systems.
- Scientific studies, services, and consultations to determine the feasibility of new programs and to increase the effectiveness of current programs.
- Quality control of products to assure the maintenance of standards for accuracy and productivity.
- Office quarters and employee housing at remote-area locations.

TRAINING

Training in weather observations, communications, maintenance, and similar technician-level skills is accomplished at schools operated by Federal agencies; professional-level training is obtained by attending accredited colleges and universities. Training costs include instructor and student pay, equipment, travel, books, and tuition.

The major portion of the Federal training effort is by Department of Defense agencies to meet their military requirements. Technician-level training is conducted at Defense schools. The Air Force and Army use civilian colleges and universities for training of their professional-level personnel. The Navy provides professional-level education leading to advanced degrees at the Naval Postgraduate School in Monterey and uses civilian colleges and universities primarily for special or doctoral degree work. Some personnel trained under these Defense programs are employed by civilian meteorological agencies after leaving the military service.

NOAA operates its National Weather Service (NWS) Technical Training Center at Kansas City for training meteorological technicians and electronics and facilities maintenance technicians. A refresher course at the professional level for meteorologists is given at NWS Headquarters in Silver Spring, Md. Other professional-level training is available through colleges and universities or in programs operated by other Federal agencies. The Coast Guard operates a Marine Science Technician (MST) Class-A School for basic training in its MST rating. Approximately 40

percent of this curriculum is devoted to meteorology, replacing the basic training obtained through the Navy's Aerographers Mate schools. The FAA Academy at Oklahoma City trains that agency's personnel in the meteorology required for air traffic control, weather observations, En Route Flight Advisory Service, and flight operations and in communications equipment maintenance. The Environmental Protection Agency conducts air pollution meteorology training programs for professionals in air pollution control at the Federal, State, and local levels.

Some economies in training are being realized through use of one agency's training program by another, avoiding duplication of facilities and staffs. Also, Commerce is effecting additional economies through home study courses, utilizing both commercial correspondence and in-house programs to supplement formal residence courses.

MAINTENANCE

Maintenance is performed at central overhaul facilities and regional and local shops. Most maintenance is local, where emphasis is placed on prevention and swift emergency actions to restore vital facilities to operation.

The Departments of Defense and Commerce operate central overhaul facilities for major repair and rebuilding on entire items or major components of equipment. Regional maintenance facilities are supported by Defense to assist local maintenance shops with preventive and corrective maintenance that is beyond local shop capability.

MANAGEMENT ABOVE OPERATING LEVEL

Management, supervision, administration, and logistic support are considered basic to units at the operating level; however, a certain amount of executive management, administration, and logistic support must come from higher echelons. In general, the management above operating level of units is confined to civil agency headquarters, to civil regional offices, and to similar headquarters in the military agencies.

Program Changes for Fiscal Year 1975

Table 21 lists the total operational costs, by agency, for each of the categories for FY 1974 and FY 1975.

The changes in the FY 1974 program for USAF shows an increase in the cost of expendables, facilities, and construction with a decrease in maintenance personnel for a net increase of $167,000, and a reduced training program for a reduction of $272,000. The Federal pay increase accounted for an increase of $1,001,000 in management above the operating level. In FY 1975, USAF plans to increase the administrative space for the AFGWC for $800,000 and increase training of observer, forecaster, and maintenance personnel at $1,292,000. The U.S. Navy is establishing small detachments at AFGWC and Keesler AFB to enhance its use of satellite data.

The additional observing equipment planned by the FAA will require additional maintenance effort. This plus the general cost of living increases account for the more significant increases in the FAA program.

Table 21.--Agency operational costs by type of general agency support
(Thousands of dollars)

Agency	Internal support		Training		Maintenance		Management above operating level		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
AEC	492	530	176	189	18	19	70	76	756	814
Commerce	4,637	4,637	1,108	1,108	15,013	15,013	21,301	21,301	42,059	42,059
Defense	3,817	4,601	16,851	17,990	11,893	11,952	10,970	10,885	43,531	45,428
EPA	200	.....	.....	.....	.....	.....	.....	.....	200	.....
NASA	100	78	21	16	355	289	54	39	530	422
Transportation:										
Coast Guard	.....	.....	77	84	.....	.....	55	58	132	142
FAA	2,917	3,262	1,695	1,740	3,779	4,116	3,126	3,723	11,517	12,841
Total	12,163	13,108	19,928	21,127	31,058	31,389	35,576	36,082	98,725	101,706

Weather Satellites

INTRODUCTION

The satellite continues its increasingly important role of observing the atmosphere. Satellite information very effectively complements other forms of data needed to produce more accurate weather analyses and forecasts, more complete and timely storm warnings, and better oceanographic forecasts. This technology is on the threshold of another significant milestone with the soon to be launched Geostationary Operational Environmental Satellite (GOES) that is expected to add a new dimension of very high resolution imagery critical to improving the environmental warning services. The prototype for this system, NASA's Synchronous Meteorological Satellites A and B, will be launched during 1974.

NATIONAL OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM

The Department of Commerce, through the National Environmental Satellite Service (NESS) of NOAA, is the agency responsible for a national operational environmental satellite system. The Department is charged with operating and improving the system to meet the common requirements of all Federal agencies.

The system is based on space technology developed by NASA, which has also procured and launched spacecraft according to Commerce specifications and is reimbursed with Commerce funds. The meteorological objectives of the operational system are:

- Viewing the atmosphere regularly and reliably on a global basis, day and night, with direct readout to local ground stations within radio range of the satellite.
- Continuous viewing of weather features and collecting and relaying environmental data from remote platforms such as buoys, ships, automatic stations, aircraft, and balloons.
- Sounding the atmosphere regularly and reliably on a global basis and providing quantitative inputs to numerical weather prediction.
- Applying meteorological satellite data to improving weather services.

The operational system consists of flight programs directed to the above objectives, Command and Data Acquisition (CDA) stations, a Satellite Operational Control Center through which satellites are controlled and data are acquired, facilities for the processing and analyzing of satellite products, and laboratories for satellite sensor experiments and developing applications of satellite data. Within the contiguous United States, some direct readout and processed products are distributed to users over facsimile networks from a central processing facility. Also within the United States, Satellite Field Services Stations (SFSS) have been established to analyze, interpret and distribute processed products to regional weather service activities.

Flight Programs

The Improved TIROS (Television Infrared Observation Satellite) Operational Satellite (ITOS) has replaced the original TIROS Operational Satellite (TOS). TOS and ITOS have provided daytime global viewing and direct readout to local ground stations without interruption since February 1966. The ITOS system is shown in figure 1.

The prototype ITOS satellite, funded by NASA and designated as TIROS M, was launched on January 23, 1970, as ITOS 1. NOAA 1--the first operational ITOS spacecraft--was launched on December 11, 1970, to provide full redundancy in orbit and assure continuity of ITOS functions. The prototype operated for 18 months and the first operational spacecraft provided service until mid-1971. The replacement spacecraft, ITOS B, launched on October 21, 1971, failed to orbit as a result of problems in the second stage of the launch vehicle, however, the Environ-

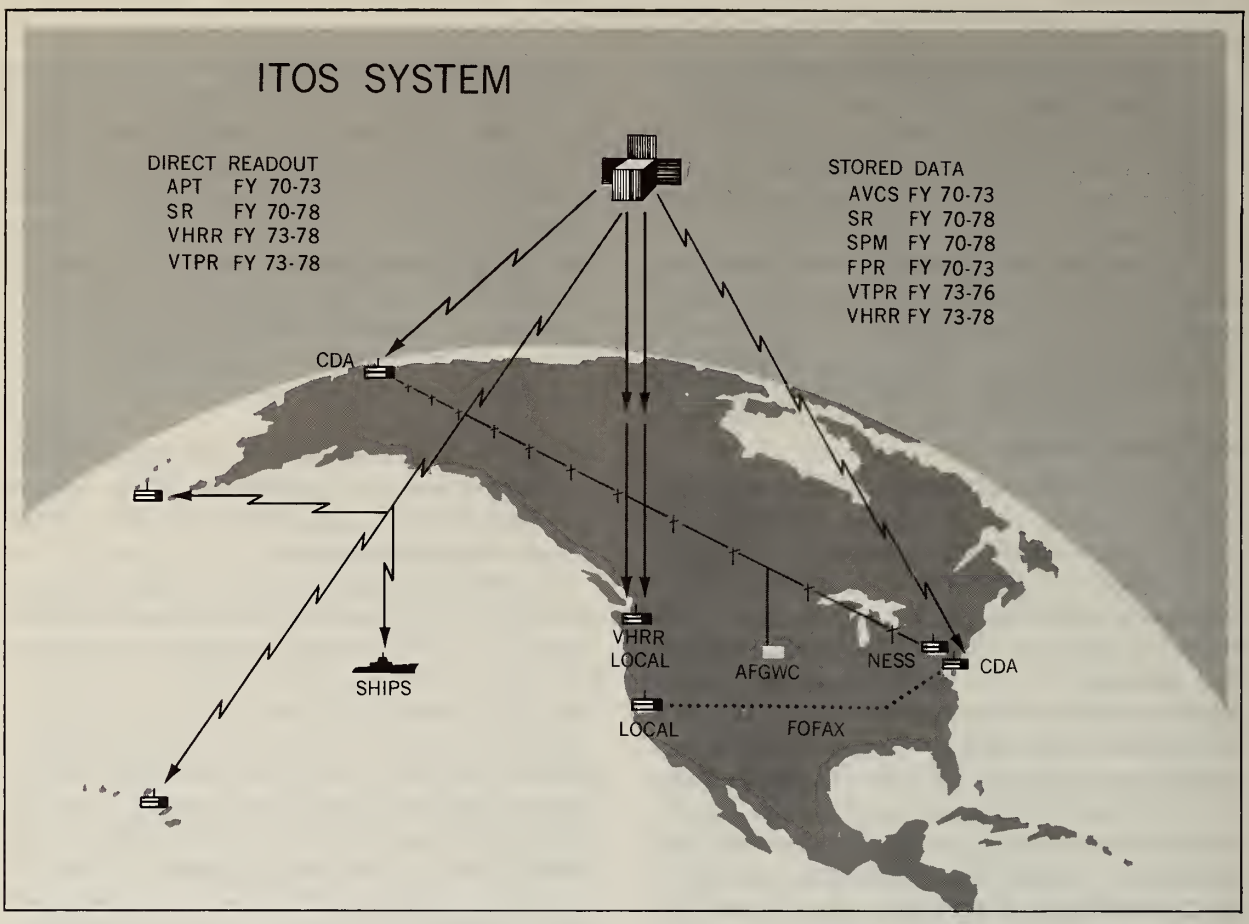


Figure 1.—Schematic of ITOS System.

mental Survey Satellite (ESSA) 8, a spacecraft of the older TOS series, continued to provide automatic picture transmission (APT), while the ESSA 9 spacecraft provided advanced vidicon camera system (AVCS) daytime service. ESSA 9 was deactivated November 15, 1973. ITOS D, designated NOAA 2, was successfully launched on October 15, 1972. NOAA 2, although similar in appearance to the earlier ITOS satellites, is the first operational environmental satellite in the series to fly with no onboard cameras, relying entirely on scanning radiometers for imagery, and is the first operational satellite to carry a sensor to obtain vertical temperature profile soundings of the atmosphere on a near-global basis.

ITOS E, whose sensor complement was identical to NOAA 2, was launched on July 16, 1973, but failed to achieve orbit because of a hydraulic pump failure in the second stage of the launch vehicle. A supplemental appropriation of $9 million was used to modify the ITOS C spacecraft to the ITOS E configuration (ITOS E2) and to begin procurement of the associated launch vehicle. ITOS F, renamed NOAA 3, was successfully launched on November 6, 1973, and became the NOAA operational satellite in early 1974. NOAA 2 serves in a backup capacity. An added feature of NOAA 3 is direct readout of the Vertical Temperature Profile Radiometer (VTPR) radiance data.

NOAA continued real-time acquisition and use of data from the NASA research satellite Applications Technology Satellite (ATS) 3 in geostationary orbit over the northwest corner of Brazil. Video data has not been obtained from ATS 1 since October 15, 1972. However, both ATS 1 and 3 are used for weather facsimile (WEFAX) transmissions of centrally prepared products to remote locations.

Tables 24 and 25 at the end of this section summarize meteorological satellite flights through 1971 and list flights launched or planned, indicating the functions provided, for the period 1972-75.

Data Applications

Global stored data are received at CDA stations, processed into products at the central processing facility, and distributed for use by the three primary analysis and forecasting centers--the NOAA National

Meteorological Center (NMC), the Air Force Global Weather Central (AFGWC), and the Navy Fleet Numerical Weather Central. The processed products are also distributed to other NOAA, Defense, and nongovernment agencies by means of facsimile landlines. The direct readout system provides regional observations in real time for detailed analysis and for use by other forecast centers and services throughout the world.

Techniques to derive quantitative information from satellite data, needed for worldwide numerical weather forecasting, continue to improve. Techniques now in use include computer-derived cloud motion vectors, improved methods for analyzing and forecasting tropical cyclone intensities, and estimates of moisture content and circulation patterns--all derived from cloud patterns. Also, in meteorologically disturbed areas, where multi-layered clouds prohibit the tracking of low-level clouds, inferences can be made about the nature and intensity of the disturbance from the pattern of high cloud vectors. Vertical temperature profiles of the atmosphere are routinely prepared from Vertical Temperature Profile Radiometer data and integrated into numerical weather forecasting programs at the National Meteorological Center. In addition, the wind and radiometric data are being used to update and improve the circulation climatology and radiation budget of tropical areas of the earth. Better knowledge of these features is essential to improve understanding of long-range changes in the general circulation of the atmosphere. Time-sequence movie loops, prepared from the near-continuous ATS 3 coverage have been integrated into NMC, National Hurricane Center (NHC), and National Severe Storms Forecast Center (NSSFC) operations and development programs.

Ways to determine sea-ice distribution and sea-surface temperature continue to be improved; for example, satellite imagery shows characteristic seasonal changes in polar ice cover. Infrared data show that some ice areas are persistently warmer than others, suggesting thinner ice in the warm regions.

Development of methods to enhance display of thermal patterns to depict Gulf Stream eddies and meanders has continued, and tracking of these eddies resumed following the launch of NOAA 2. Mesoscale prediction techniques were developed for summer thunderstorms using satellite photographs. Mini-squall lines expanding from convective storms were monitored using animated picture sequences. Techniques for determining thaw conditions of snowfields using comparative analysis of observations in the visible and near-infrared spectra have been verified with data from NASA's Earth Resources Technology Satellite, and satellite infrared measurements have been useful for mapping snow cover extent. This information is important for water resources management and flood forecasting. For example, snow maps derived from VHRR data, were prepared for the American River, Feather River, Upper Columbia River, Red River of the North, and Genesee River basins. In addition quantitative snow cover data were sent to River Forecast Centers for use in river and flood potential forecasts. Satellite imagery has been used to support the International Field Year for the Great Lakes (IFYGL) program. Thermal and ice conditions of the Lakes have been derived from these data. Satellite imagery has played an important role in marine pollution monitoring. Comparison with airborne remote sensing imagery reveals areas of intense pollution in the coastal zone.

OPERATIONAL PLAN

Spacecraft and Launching

The ITOS system will be maintained in operation with launches at about 1-year intervals, as required until the third quarter of 1977. ITOS G is scheduled for launch in the first quarter of FY 1975; ITOS E2, scheduled for launch a year later, will be available as a backup.

Spacecraft of this series are launched into retrograde polar orbit (102° inclination) so that the precession of the satellite's orbit compensates for the earth's motion around the sun. Such an orbit is said to be sun-synchronous because the satellite crosses a given latitude at the same local (solar) time on each revolution. By choosing the optimum viewing time for sun-angle and diurnal variation of cloudiness, a satellite system can be planned to meet particular operational objectives. The NOAA-series satellites, designed to meet the needs of basic meteorological service, reach their highest northern latitude in the early afternoon, passing over the mid-latitudes in mid-afternoon and mid-morning. Table 25 lists the orbital elements and observing functions of all working meteorological satellites.

Beginning with NOAA 2, these satellites include a capability for obtaining vertical temperature profiles and total moisture content of a column of the atmosphere. Addition of the Vertical Temperature Profile Radiometer (VTPR) system completes the first operational system for sounding the atmosphere

twice daily on a global basis, a major objective of the national operational environmental satellite program. NOAA 3 was the first ITOS satellite to provide a direct readout capability of the VTPR data, although limited to special receiving equipment.

The Very High Resolution Radiometer (VHRR) system provides high resolution imagery (0.8 kilometers under satellite track). The VHRR operates mainly as a unique local readout subsystem to specially equipped locations, with limited high-resolution storage capacity for data from selected remote areas. The vidicon camera systems in use on the earlier ITOS have been discontinued; their daytime viewing is performed by the combined day and night viewing and temperature sensing Scanning Radiometer (SR). The primary sensor complement--SR, VHRR, and VTPR--is expected to continue on the polar-orbiting satellites into FY 1978. The APT service will continue with the signal provided by the SR; day and night service is available from the SR which observes in both the visible and infrared spectra. SR data may be received on the conventional ground-station recorder formerly used for APT signals, provided it is suitably modified. The details of the modification vary with the manufacturer and type of recorder. A Solar Proton Monitor (SPM) is carried as a secondary sensor.

The ITOS series of operational environmental satellites in polar orbit will be replaced by a new series during FY 1978. Definition and specification of the ground system for this next generation spacecraft will begin during FY 1975. Procurement of long lead time ground equipment also will begin in FY 1975.

The initial capability for near-continuous day and night cloud viewing and data collection-and-relay will be established with launch of the Synchronous Meteorological Satellite (SMS), the SMS A and B--the NASA-funded prototypes for the Geostationary Operational Environmental Satellite (GOES). NOAA is funding the followup operational GOES spacecraft to maintain the GOES system. The overall SMS/GOES System concept is shown in figure 2. The SMS/GOES will carry the Visual and Infrared Spin-Scan Radiometer (VISSR) system, providing nearly continuous observation of cloud cover, day and night, and measurements of cloud-top and surface temperatures. Wind information will be derived from cloud motions. This system will meet the needs for observations of rapid changes in weather situations important to improving short range forecast and advisory services. It will provide almost constant surveillance of the development and movement of destructive weather systems such as tropical storms and hurricanes, thunderstorms and tornadoes, and major mid-latitude storm systems.

Also included is a Data Collection System (DCS) for obtaining environmental information observed at remote locations and relaying these data to a central location for further distribution. The DCS is shown in figure 3. A Space Environment Monitor also will be carried; data obtained will be used in providing real-time warnings of solar disturbances.

An integral part of the SMS/GOES system concept is the Central Data Distribution System (CDDS) shown in figure 4. Stretched VISSR data will reach the SFSSs for further dissemination to regional environmental activities via the Wallops CDA, the satellite, and the CDDS. Infrared imagery is transmitted directly to the SFSSs via the CDA. In addition, these data will be supplied to the Winds Derivation Unit and several other units collocated with the CDDS.

A VISSR picture of the entire earth disk will be available every 30 minutes. Since the accumulation of data is too voluminous to transmit on a real time basis, the data will be reduced to smaller geographical areas called sectors. These sectors, in turn, will be transmitted to the applicable SFSS. The Weather Service Forecast Offices will receive sectors of the VISSR data from the appropriate SFSS for display and local use. The infrared data will be transmitted directly from the CDA station to the SFSS and reduced to video imagery for analysis and interpretation. In the event of catastrophic failure of the CDDS sectorizing effort, infrared data will continue to be available at the SFSS.

The two prototype geostationary satellites, SMS A and B, will be launched during 1974. Operating positions for these satellites will be over the equator near 70° and 130° west longitude. However, one satellite initially will be located in a position whereby imagery of all the tropical Atlantic and the GATE project area will be available. After GATE this satellite will be moved westward to its designated operating location. Should launch delays develop or either satellite fail to orbit, there are contingencies regarding deployment of the spacecraft. The first NOAA funded GOES satellite is scheduled for launch late in 1974 and will serve as an "in orbit" backup for the two SMS spacecraft. These satellites will afford near-continuous high-resolution surveillance of an area 6,500 nautical miles in diameter beneath each

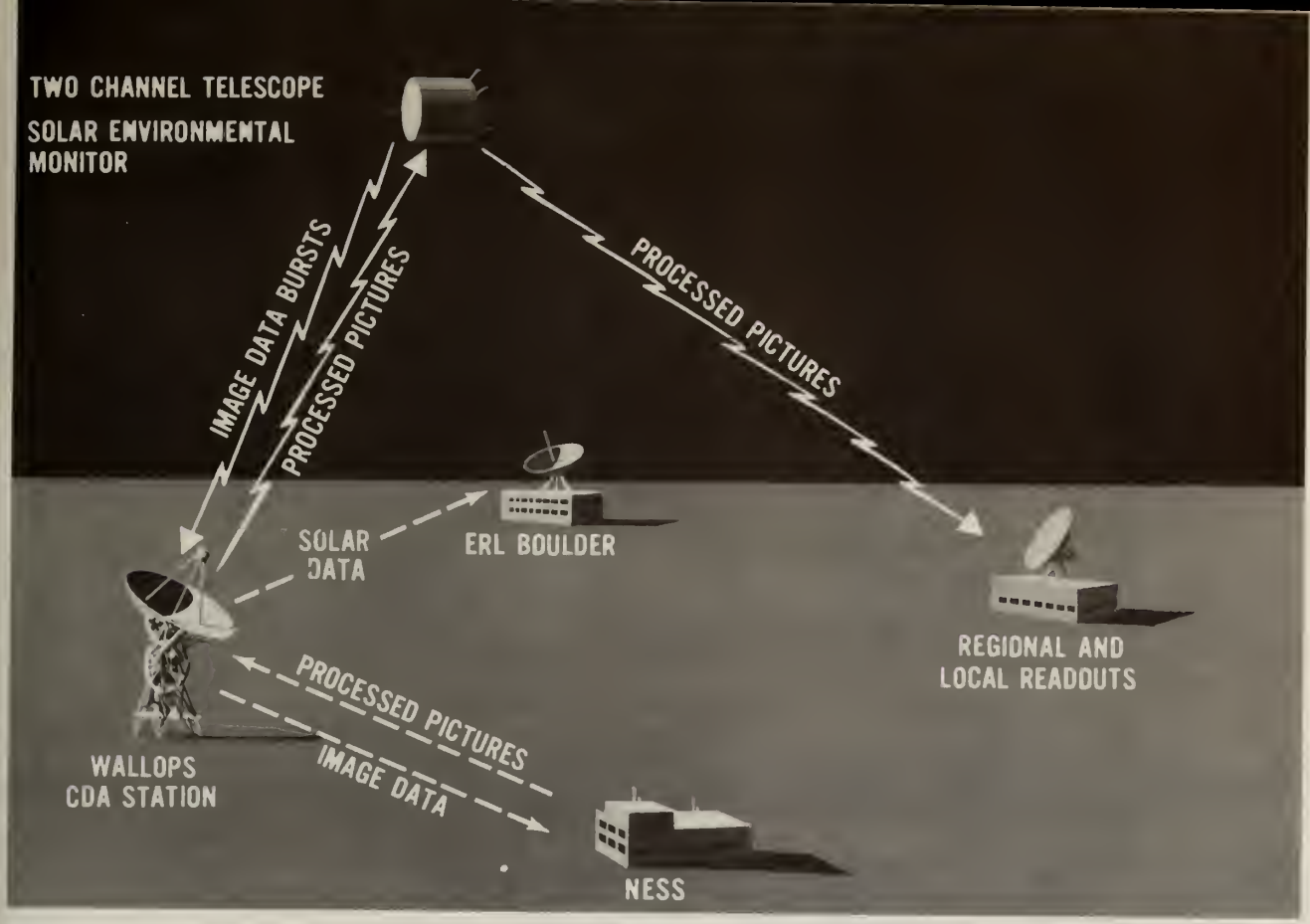
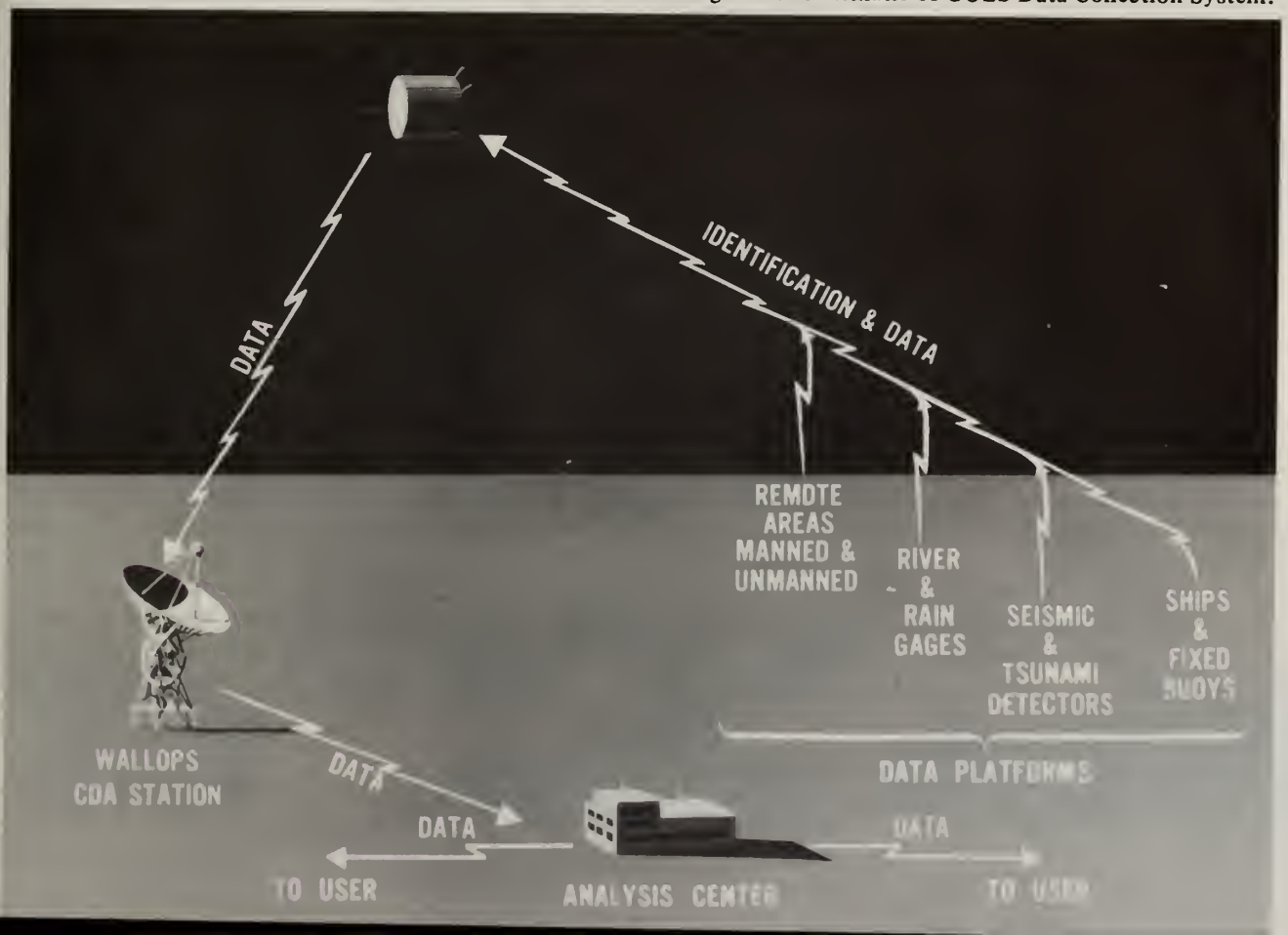


Figure 2.—Schematic of SMS/GOES system concept.

Figure 3.—Schematic of GOES Data Collection System.



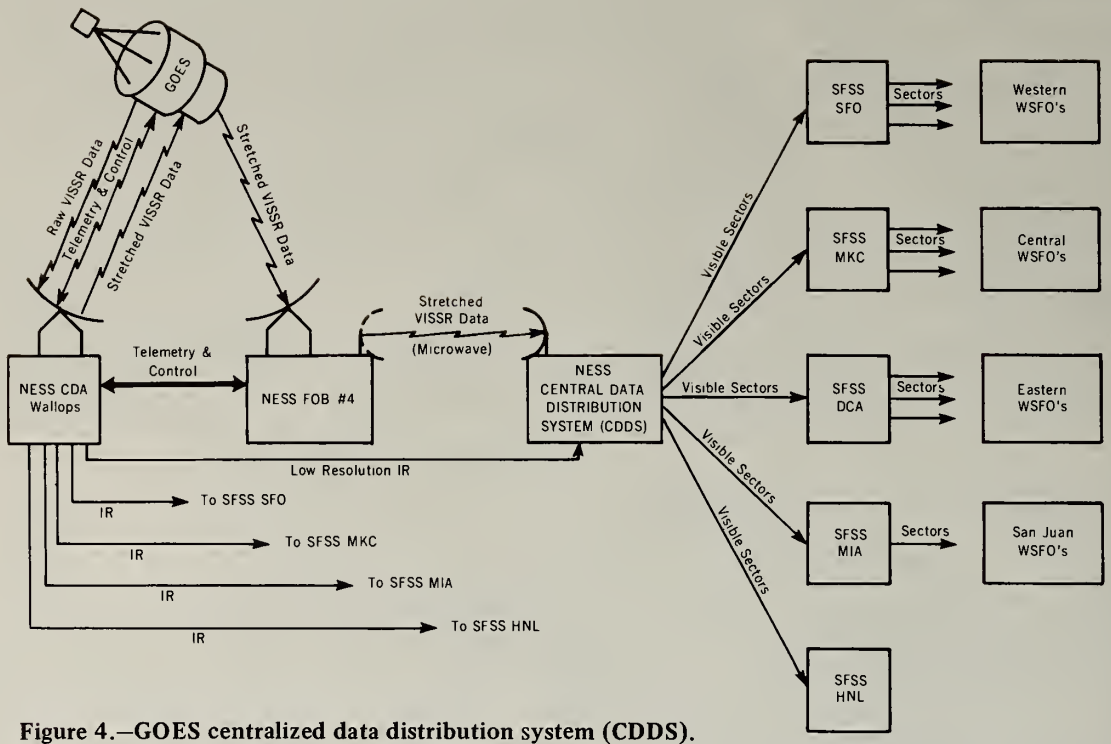


Figure 4.—GOES centralized data distribution system (CDDS).

spacecraft and relay of data over an area of about 9,500 nautical miles in diameter. It is planned to maintain two satellites in geostationary orbit, providing near-continuous viewing and data collection-and-relay over a major part of the Western Hemisphere. Figure 5 shows the area of coverage by the two geostationary satellite systems.

NOAA plans for FY 1975 funding of spacecraft programs include the continued procurement of ITOS H and I spacecraft and parts for ITOS J; post launch evaluation of GOES A and continued fabrication of GOES B and C; and starting procurement of ground equipment for the third generation of polar orbiting operational spacecraft. Additional funding in FY 1974 was requested for ITOS E2 needed to fill the gap created by the loss of ITOS E. Fiscal year 1975 launch requirements include funds to complete the ITOS E2 and H launch vehicles, to begin procurement of the ITOS I and GOES B vehicle, and to procure launch services for ITOS E2.

Command and Data Acquisition

The NOAA CDA stations, located at Wallops Station, Va., and Gilmore Creek, Alaska, have been equipped and staffed to maintain and operate previously approved programs and to proceed with planned program improvements. Equipment and staff are complete for the ongoing ITOS program and for the one-satellite operational GOES system. Equipment required for the operational two-satellite GOES system is being procured and will be installed to make the system operational in late FY 1974.

Data Processing

NESS and AFGWC receive the stored scanning radiometer data from the ITOS spacecraft for computer processing. NESS uses the NOAA central computers, smaller computers, and manual techniques to convert observational data into forms suitable for immediate use in analysis and forecasting routines and for subsequent research and climatological use.

Among the principal products and services derived from the satellite observed data are: vertical temperature profiles; computer produced cloud cover mosaics and charts of cloud-top temperatures and heights; total atmospheric water content and wind vectors; charts depicting oceanographic and hydrologic conditions; and interpretations of these data in support of meteorological analysis and forecasts. The data are

exchanged internationally and are permanently archived for use in developing new techniques for using satellite data and for other research purposes.

DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP)

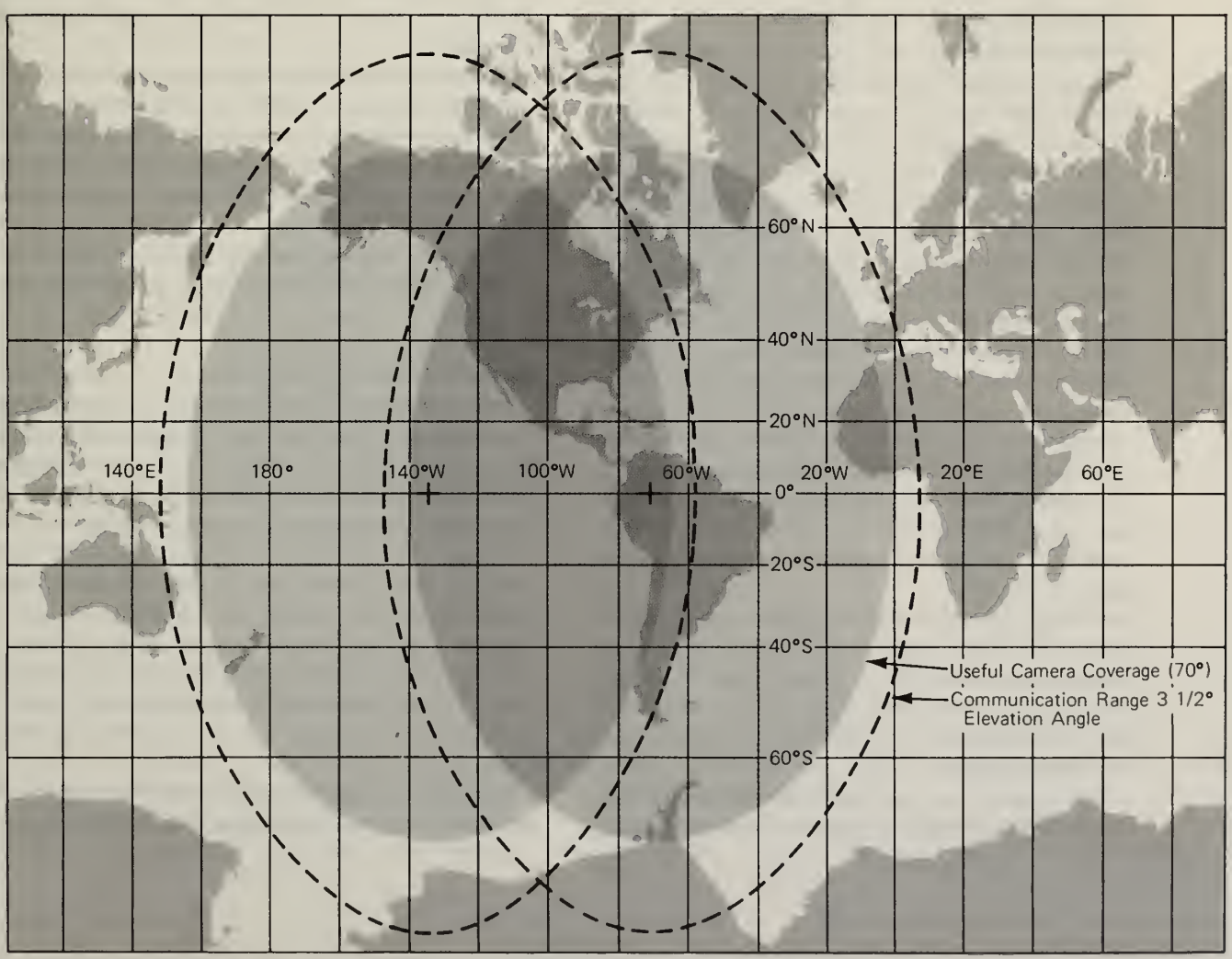
The Defense Meteorological Satellite Program (DMSP) is an operational polar-orbiting system managed by the USAF. Formerly called DAPP and DSAP, DMSP is a DOD meteorological satellite system the data from which has been recently declassified. The USAF furnishes DMSP data and all specificiations for their use to NOAA/NESS as well as to DOD meteorologists. NOAA/NESS is responsible for further dissemination of DMSP data to other U.S. government agencies and to the U.S. and international scientific communities.

Operational Characteristics

The DMSP was designed and developed to provide unique meteorological data required by the DOD. It was designed under a total system concept in which not only sensors, but communications and ground processing facilities were developed with the primary objective of providing maximum responsiveness to the military decision-maker. DMSP provides visual, IR and vertical temperature information to the Air Force Global Weather Central (AFGWC), Offutt AFB, Nebr., for the entire globe at four observation times per day. DMSP provides direct real-time readout of regional visual and IR data to selected military locations around the world.

The DMSP routinely employs two polar-orbiting satellites. Each satellite is in an approximate 450 nautical mile circular orbit with a period of 101

Figure 5.—Useful camera coverage (shaded areas) and communications range (dashed lines) of a two GOES system.



minutes. One satellite has an early morning local ascending equator crossing time and the other has a near-noon ascending equator crossing time.

Both satellites have visual and IR scanning radiometers. The visual sensors detect the brightness of reflected solar illumination from .4 to 1.1 micrometers (μm) . The IR sensors measure emitted radiation from 8 to 13 μm. The IR products are images of the earth and its atmosphere which are representative of their temperatures. Both IR and visual data may be obtained at a resolution of either one third or two nautical miles. The spectral band width of the visual sensors was selected to optimize distinction among clouds, ground, and water. Electronic circuitry in the sensor converts the sensed IR energy directly into equivalent blackbody temperature, making temperature the directly displayed parameter. The sensitivity of the two nautical mile visual channel covers seven orders of magnitude; this enables it to provide useful meteorological information from full daylight over highly reflective scenes to an illumination level roughly equivalent to half moon light.

Data Readout, Communications, and Data Processing

DMSP communications and ground processing systems are designed to produce usable products within five minutes of termination of the data stream. For direct readout, this means a data age of five to twenty minutes when ready for application to operational decisions. The central processing facility, AFGWC, is linked to the DMSP readout facilities by real time, wideband communications. This allows for real time recovery of (stored) recorded data such that the only timing increment added to the processing time is the transit time of the DMSP satellite from the observation scene to readout circle.

The data display unit has been designed with the following features to facilitate data interpretation:

- Orbital Normalization--Compensates for altitude and attitude differences.
- Equal Area Projection--Foreshortening at the edges is removed.
- Large Scale Transparency--The nominal scale is switch selectable at either 1:7.5 or 1:15 million.
- Enhancement Options (Visual Data)--Variations in solar illumination are compensated for. The visual imagery displayed can be enhanced in the low, high, or a low-high mode.

Low enhancement gives better detail and definition to low albedo subjects like terrain, whereas high enhancement gives better detail to high albedo subjects like bright clouds. The combination of low-high enhancement gives improved detail to both low and high albedo features.

- Thresholding and Scale Expansion (IR Data). Thresholding segments the data into four levels (e.g., when thresholding at 270°K, 260°K, and 230°K, temperatures colder than 230°K are depicted as white, temperatures between 260°K and 230°K are depicted as light gray, temperatures between 270°K and 260°K are depicted as dark gray, and temperatures warmer than 270°K are depicted as black). The Scale Expansion allows the setting of a base temperature (e.g., 310°K) and displaying 16 shades of gray over 100°K (1:1 expand 310°K to 210°K), 50°K (2:1 expand, 310°K to 260°K), and 25°K (4:1 expand, 310°K to 285°K).

The entire ground system for direct, local readout is contained in a self-enclosed unit, including antenna, which is air transportable, making overseas deployment to full scale operation a matter of hours. Additionally, the Navy has developed a similar local readout system for shipboard use. The centralized processing facility (AFGWC) has the following capabilities:

- Display high quality imagery for manual use.
- Input the raw DMSP data stream directly into computers where it is converted into cloud parameters and collated with conventional meteorological data to produce a comprehensive numerical cloud analysis.

Table 22 lists the agency operational weather satellite program costs, by function, for FY 1974 and FY 1975.

SUPPORTING RESEARCH

Meteorological research conducted by NASA and the Departments of Commerce and Defense provides the data utilization techniques necessary to meet these agencies' major long-term objectives for a coordinated meteorological satellite program.

Global viewing, the first major objective, was largely achieved with the TIROS M and ITOS spacecraft. Efforts continue toward improved resolution, location, and display. Attention is also being given to developing methods for measuring additional environmental properties, to solving data and product distribution problems, and to improving ground stations.

The second major objective includes both continuous viewing and collecting and relaying meteoro-

Table 22.--Agency operational weather satellite program costs, by function
(Thousands of dollars)

Agency	Spacecraft and launching		Command and data acquisition		Data Processing		Technical management and support		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	34,398	31,688	6,308	7,064	13,040	16,035	4,625	5,313	58,371	60,100
Defense:										
Navy	.....	.....	1,645	4,406	2,173	4,552	200	200	4,018	9,158
Air Force	10,600	17,100	8,474	3,396	869	1,088	680	680	20,623	22,264
Total	44,998	48,788	16,427	14,866	16,082	21,675	5,505	6,193	83,012	91,522

logical data from instrumented platforms such as buoys, ships, automatic stations, aircraft, and balloons. NASA conducts experiments in support of this objective with its Nimbus and ATS series and is funding the SMS prototypes for the GOES operational spacecraft.

The third major objective--regular and reliable atmospheric sounding on a global basis and quantitative inputs to numerical weather prediction--is also being supported by NASA in experiments on the Nimbus series and by NASA development of an advanced operational atmospheric sounder for the new series of spacecraft. Research and development for the third major objective are emphasized in NASA's Nimbus program and in NOAA's program to develop sensing techniques. Nimbus 4 continues in operation in orbit more than 3½ years after launch. Useful data are still regularly obtained from the Image Dissector Camera System (by direct readout only), the Interrogation, Recording, and Location System, the Backscatter Ultraviolet Experiment, and the Monitor of Ultraviolet Solar Energy. Nimbus 5 was successfully launched December 11, 1972, and has successfully met all its objectives. Included in the experiments was the first exploratory use of the microwave region of the spectrum for atmospheric sounding. Passive microwave and infrared sensors demonstrated the feasibility of determining vertical profiles of temperature and water vapor through cloud cover to the surface. An advanced scanning microwave radiometer provided day and night mapping of liquid atmospheric water, sea and land ice and soil moisture. An advanced infrared radiometer provided improved spatial resolution and identification of surface features. Nimbus F, to be launched in mid CY 1974, will provide improved capabilities in most of these areas, as well as improved vertical range and resolution of atmospheric sounding. Nimbus F, as part of its mission, will make substantial contribution to the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE). The Nimbus program has been extended with the approval of Nimbus G for launch in 1977. This mission will provide spaceborne sensors applicable to studies of air pollution, oceanography, the ocean/atmosphere interface, and the earth and atmosphere heat budget.

Commerce, Defense, and NASA conduct a wide variety of studies on the applications of meteorological satellite data to improve services--the fourth major objective. Efforts will be directed to developing new methods for using satellite data in environmental analysis and forecasting. The radiative and optical properties of atmospheric constituents are being studied to aid the design of satellite-borne sensors and the interpretation of data from them. Special attention is given to interpreting and validating new data acquired by operational and research satellites and to applying these data as inputs to numerical analysis and forecasting.

Meteorological satellite research is described in detail in the *Federal Plan for Meteorological Data from Satellites*, in particular the description of the polar-orbiting satellites Nimbus E and F, the third generation operational satellite system, the geosynchronous meteorological satellite, and the description of developmental applications.

Table 23 lists the agency funding the research, by function, for the weather satellite program.

Table 23.--Agency supporting research weather satellite program costs, by function
(Thousands of dollars)

Agency	Satellite flight projects		Satellite instruments and experiments		Spacecraft technology and associated ground equipment		Satellite data analysis and applications		Total	
	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75	FY 74	FY 75
Commerce	.....	.....	1,400	1,738	.....	.....	1,921	1,904	3,321	3,642
Defense:										
Army	.....	.....	.....	.....	.....	.....	1,345	1,325	1,345	1,325
Navy	.....	.....	.....	.....	.....	.....	200	200	200	200
Air Force	.....	.....	3,800	3,800	3,200	600	658	647	7,658	5,047
NASA	18,746	19,431	6,544	7,898	735	1,197	7,688	8,091	33,713	36,617
Total	18,746	19,431	11,744	13,436	3,935	1,797	11,812	12,167	46,237	46,831

Table 24.--Summary of meteorological satellite flights, 1960-71

Satellite	Purpose	Launch Date	Operations ceased date
TIROS I	Research	4/ 1/60	6/15/60
TIROS II	Research	11/23/60	2/ 7/61
TIROS III	Research	7/12/61	10/30/61
TIROS IV	Research	2/ 8/62	6/12/62
TIROS V	Research	6/19/62	5/ 5/63
TIROS VI	Research	9/18/62	10/11/63
TIROS VII	Research	6/19/63	2/ 3/66
TIROS VIII	Research	12/21/63	1/22/66
Nimbus I	Research	8/28/64	9/23/64
TIROS IX	Research	1/22/65	2/15/67
TIROS X	Operational	7/ 1/65	7/31/66
ESSA 1	Operational	2/ 3/66	5/ 8/67
ESSA 2	Operational	2/28/66	10/16/70
Nimbus 2	Research	5/15/66	11/15/66
ESSA 3	Operational	10/ 2/66	10/19/68
ATS 1	Research	12/ 6/66	(1)
ESSA 4	Operational	1/26/67	6/19/67
ATS 2	Research	4/ 5/67	(2)
ESSA 5	Operational	4/20/67	2/20/70
ATS 3	Research	11/ 5/67	--
ESSA 6	Operational	11/10/67	11/ 4/69
ESSA 7	Operational	8/16/68	7/19/69
ESSA 8	Operational	12/15/68	--
ESSA 9	Operational	2/26/69	--
Nimbus 3	Research	4/14/69	9/25/70
ITOS 1	Operational	1/23/70	6/--/71
Nimbus 4	Research	4/ 8/70	(3)
NOAA 1	Operational	12/11/70	8/--/71
ITOS B	Operational	10/21/71	(4)

[1] Imagery not available.
[2] Unstable attitude; data not useful.
[3] THIR, FWS, and IRIS not operable.
[4] Failed to orbit.

Table 25.--Meteorological satellite flights and functions

Satellite	Purpose[1]	Launch	Orbit[2]	Functions[3]	Remarks
Nimbus 5	R	12/12/72	S/1110	Image, Sounding, Relay	
NOAA 2	O	10/15/72	S/1460	Image, Sounding, Space	Standby-VTPR out Mar. 18, 1974
ITOS E	O	7/16/73	S/1460	Image, Sounding, Space	Failed to orbit.
NOAA 3	O	11/ 6/73	S/1510	Image, Sounding, Space	Primary, March 19, 1974.
DMSP	O	8/16/73	S/830	Image	Low light level image.
SMS A	R/O	5/17/74	G/35700	Image, Relay, Space	Atlantic.
SMS B	R/O	/74	G/35700	Image, Relay, Space	Eastern Pacific
Nimbus F	R	10/ /74	S/1110	Image, Sounding, Relay	
ITOS G	O	7/ /74	S/1460	Image, Sounding, Space	
GOES A	O	/74	G/35700	Image, Relay, Space	Note 4
ITOS E2	O	8/ /75	S/1460	Image, Sounding, Space	Former ITOS C Spacecraft.

[1] R--Research, O--Operational, R/O--Operational Prototype.

[2] S--Sun-synchronous, G--Geosynchronous/altitude in kilometers.

[3] Image--TV-like picture of cloud patterns or sea-surface temperature patterns.
Sounding--Vertical profile of atmospheric temperature, water vapor, or ozone.
Relay--Relay and tracking of surface or balloon-borne sensors.
Space--Measurement of space radiation or solar emissions.

[4] To be stored in orbit as replacement for SMS A or B.

PUBLICATIONS

The Federal Coordinator for Meteorological Services and Supporting Research has either prepared or is preparing a series of publications covering the broad spectrum of meteorological programs in the Federal Government. The following is a list of these publications and their status:

The Federal Plan for Meteorological Services and Supporting Research (Published annually)

World Weather Program Plan (Published annually)

National East Coast Winter Storms Operations Plan (Revised annually)

National Hurricane Operations Plan (Revised annually)

National Severe Local Storms Operations Plan (Revised annually)

Report of the National Committee for Clear Air Turbulence (December 1966)

Federal Plan for a National Fire-Weather Service (March 1967)

Mesometeorological Research and Development Prospectus (March 1967)

Implementation Plan for the ESSA/USAF Joint-Use Computer Facility at Asheville, N.C. (May 1967)

Federal Plan for Marine Meteorological Services (May 1968)

Planning Guidelines for a Federal Aviation Meteorological Service (August 1968)

The Joint Selection Panel Report on the ESSA/USAF Joint-Use Computer Facility at Asheville, N.C. (January 1969)

Catalog of U.S. Government Meteorological Research and Test Facilities (September 1969)

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